THE
GEOGRAPHICAL REVIEW

VOLUME XV, 1925

PUBLISHED BY
THE AMERICAN GEOGRAPHICAL SOCIETY
BROADWAY AT 156TH STREET
NEW YORK

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VOL. XV | JANUARY, 1925 | NO. 1

THE DISTRIBUTION OF POPULATION IN CHINA
ECONOMIC AND POLITICAL SIGNIFICANCE*

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University of Liverpool

ESTIMATES OF POPULATION IN CHINA

It is well known that the difficulties in estimating the population of China are very great, in spite of the fact that the census was an extremely ancient institution of the Empire. Under the old tithing system we are told that "Each district had its appropriate officer, each street its constable, and every ten houses had a tithing man." But down to 1741 practically all the census estimates were made on the basis of tax-paying householders, and it is very hazardous to institute any comparison between the recorded population of the Ming or Early Manchu periods and that of recent times.

In the later years of the Empire there were two important census returns, the Board of Revenue Census of 1885 and the Board of Interior (or Minchengpu) Census of 1910, the year before the fall of the Manchus. According to the first, the population of China (excluding Manchuria) was 377,636,000, according to the second 331,188,000 (inclusive of Manchuria). The Minchengpu Census, however, was mainly estimated by families, the multiple employed to establish the number of individuals being 5.5.

In 1918 a special committee of the China Continuation Committee, desiring to prepare an exhaustive survey of the actual condition and prospects of missionary work in China, endeavored through the Police Commissioners and other official sources to obtain the latest official estimates of population by *hsiens*. The figures so obtained were submitted to competent missionary representatives in the different provinces for purposes of checking, and in

*This article is based upon a paper read before Section E of the British Association for the Advancement of Science at the Toronto meeting in August, 1924. The writer is indebted for the dot maps showing the distribution of population, the distribution of cities of 100,000 or over, and the distribution of spoken languages to the compilers of the large survey volume of the China Continuation Committee entitled "The Christian Occupation of China." Of this work only a limited number of copies were published. The Survey Committee is to be congratulated on the great contribution to our knowledge of China which the collection and sifting of the data involved have made, apart altogether from the special purpose in view.

this way the Survey Committee had about 150 correspondents to assist it in its task. In the later stages of the work the figures were checked from independent estimates of the Chinese Post Office, one of the most efficient organizations in modern China. Ultimately the two estimates were separately issued, the one being known as the China Continuation Committee's Estimate of 1918–1919 and the other as the Post Office Census of 1920. Between them they represent the most scientific and probably the most reliable computation of the population of China that has yet been made. The degree of accuracy obtained no doubt varies greatly in the different provinces. In what may be termed the "Home" Provinces the figures are much more reliable than for such isolated and outlying provinces as Szechwan and Kansu. The two estimates closely correspond in the former case, e. g.

	C. C. C.	P. O.
Shantung	30,955,000	30,803,000
Shansi	10,891,000	11,080,000
Kiangsu	33,678,000	33,786,000

In the western provinces there is often wide discrepancy, particularly in the case of Szechwan, which has always presented special difficulties to compilers of statistics. There have been recent changes in the definition of the province (see Fig. 10), and the basis of the two estimates is unfortunately not the same.

	C. C. C.	P. O.
Szechwan	61,444,000	49,782,000

The total population of China is in both cases exclusive of that of Mongolia, Inner and Outer, Sinkiang, and Tibet with Kokonor and is returned as follows:

	C. C. C.	P. O.
China	440,925,000	427,679,000

The compilers, at any rate those of the C. C. C. figures, are inclined to think that their estimates are too high, and we may probably conclude that according to the most recent evidence and the most reliable records obtainable the population of China Proper, which, it must be remembered, now includes the three Manchurian provinces, is about 400 millions.

One other general point of interest is that these two recent estimates agree as to the order, in density per square mile, of the four most densely peopled provinces, viz.:

	C. C. C.	P. O.
Kiangsu	872	875
Chekiang	624	600
Shantung	553	500
Honan	479	454

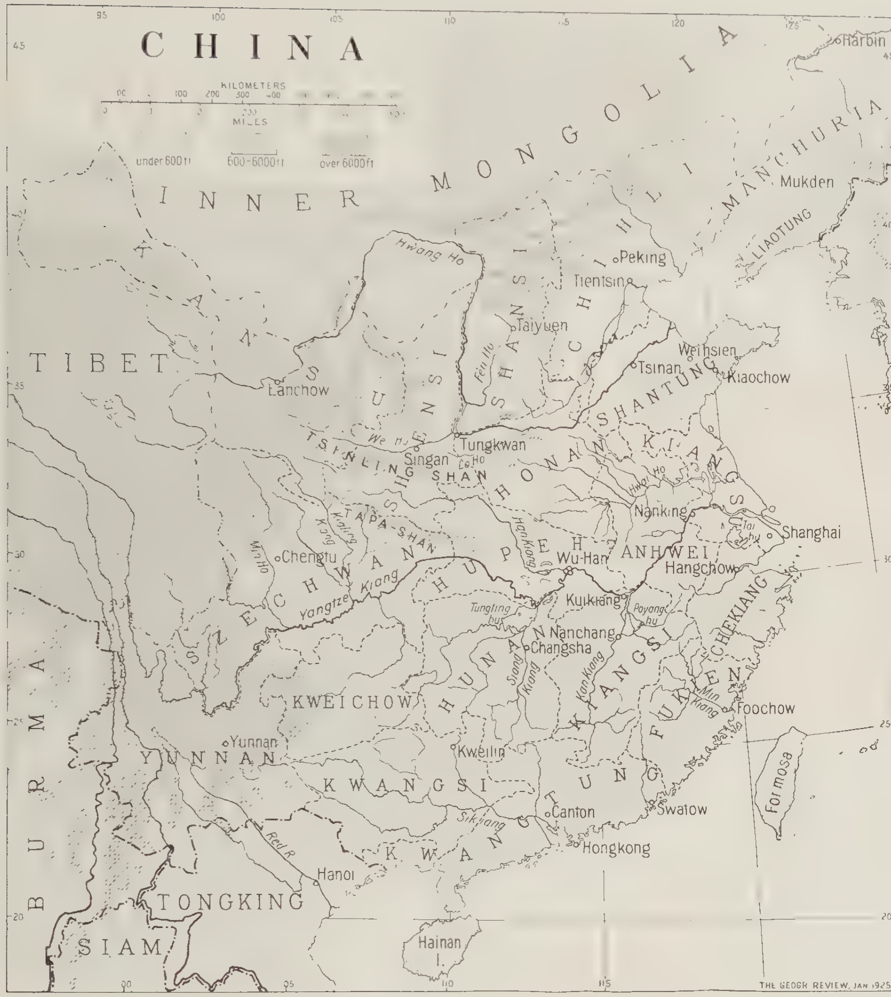

FIG. 1—Map of China to serve as a key to the distributional maps. Scale approximately 1:25,000,000.

With these it is interesting to compare Belgium, the most densely peopled country of Europe, with 657 people to the square mile; England and Wales with 618; and Rhode Island, the most densely peopled North American political unit, with 508. Kiangsu would seem to be the most densely peopled political unit in the world. In previous estimates this doubtful distinction was assigned to Shantung.

THE LARGER NATURAL ENTITIES

It is obvious that the distribution of population by provinces gives us a very imperfect and indeed fallacious impression of the real position, since the provinces of China correspond in size to the countries of Europe and frequently, as in the case of Shantung, contain quite distinct natural regions.

This of course does not imply that the Chinese provinces have no geographical significance. That is a question of considerable interest but beyond the scope of this article. The very ancient units of the *hsiens*, on the other hand, correspond broadly in size to English counties,[1] so that by the new method of representation adopted by the C. C. C. it is possible to obtain for the first time a broad *regional* view of the distribution of population in China. As a preliminary to the study of the facts as thus represented it is necessary to state what seem to be the largest physiographic divisions of that vast country. We are not yet in a position to distinguish clearly the natural regions of China on a really scientific basis, such as has been adopted for France or the United States. The following classification, although no doubt open to considerable criticism, may, however, serve to indicate provisionally the larger natural entities:

1. The Great Plain of North China.
2. The Highlands of Northeast China, surviving parts of the old "Fundamental Complex," consisting very largely of Archaean gneiss and granite. These Highlands comprise:
    a. The Shantung Mountains, consisting of two distinct blocks, separated by the Weihsien-Kiaochow Valley Corridor.
    b. The Liaotung Peninsula.
    c. The East Manchurian Highlands.
3. The Central Lowland of Manchuria.
4. The broken edges of the Mongolian-West Manchurian Plateau contained within China Proper, although lying outside the Great Wall.
5. The Loess Plateau of Northwest China.
6. The Wei-ho Valley Lowland which lies between the Loess Plateau and
7. The Mountain Belt of Central China (Tsin-ling, Tapa-shan, etc.), sufficiently broad to constitute a distinct topographical unit.
8. The Yangtze Deltaic Region. This belongs physiographically to the North China Plain, but it has distinctive soil conditions, and, if its space relations and special economic characteristics are taken into account, it may be considered permissible, as it is certainly convenient, to distinguish it as a separate region.
9. The Central Basin, or Basin of Hupeh, inclusive of the great alluvial tracts round the Tungting and Poyang Lakes and of the important river valleys converging on them.
10. The Red Basin of Szechwan, of which the Plain of Chengtu is an important subregion.
11. The Szechwanese Alps.
12. The Coastal Fringe between the Yangtze and the Sikiang, comprising a narrow belt of the provinces of Chekiang, Fukien, and Kwangtung lying between the easternmost, or maritime, scarp of the South China Plateau and the sea.

[1] The province of Shensi, e. g., has an area of 72,290 square miles and is divided into 90 *hsiens*. England and Wales have an area of 58,340 square miles and contain 55 counties (including the county of London).

FIG. 2—The density of population in China. This and the succeeding maps are reproduced by permission from the China Continuation Committee's volume "The Christian Occupation of China," Shanghai, 1922.

13. The Plateau of South China. This of course can only be considered as a unit in the very broadest sense. It contains a large number of subregions, and, from the point of view of soil conditions dependent upon geological formation, there is probably an important distinction between the eastern section (the "Southeast China island" of de Launay,[2]) mainly composed of old metamorphic and granitic rocks, and the western section of sedimentary Mesozoic rocks, particularly limestones.

14. The High Plateau of Yünnan.

15. The Canton Delta and Lower Sikiang Valley.

[2] Louis de Launay: La géologie et les richesses minérales de l'Asie, Paris, 1911.

Fig. 3

Fig. 4

Figs. 3 and 4—Harvest and farm scenes in the North China Plain, near Peking.

Fig. 5

Fig. 6

Fig. 5—A sandy, uncultivated tract of country in Honan, typical of portions of the North China Plain.
Fig. 6—The Plain of South Manchuria, near Mukden.

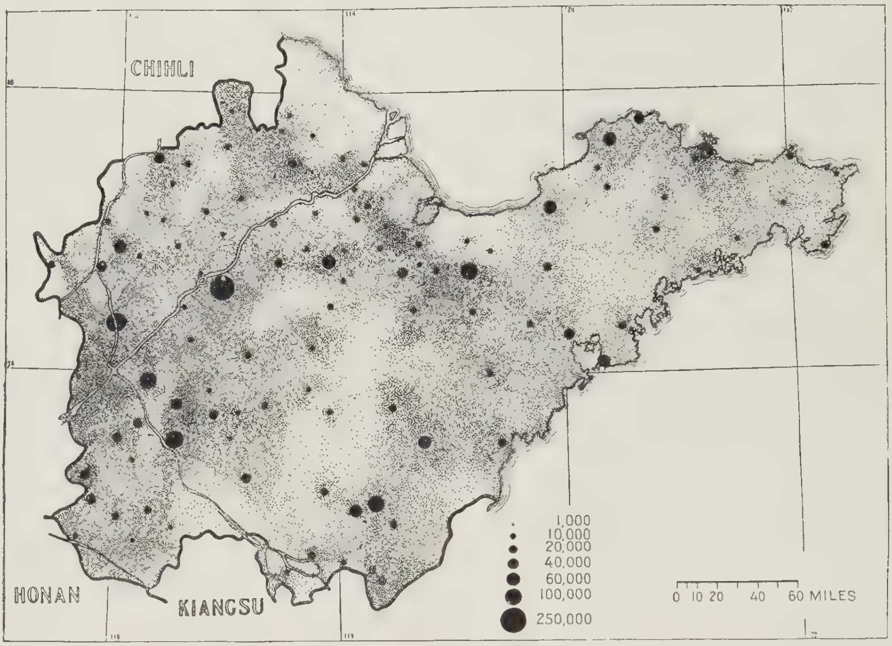

FIG. 7 -Density of population in Shantung.

REGIONAL DISTRIBUTION OF POPULATION

If in relation to this tentative statement of the larger natural entities of China we now review the outstanding features of the distribution of population as shown in Figure 2, we are at once impressed by its extreme concentration into certain regions of limited size. The districts of very high density are:

A. The central portion of the Great Plain of North China, comprising politically western Shantung, northeastern Honan, southeastern Chihli, and the extreme northern border of Anhwei. The rest of the Great Plain is, for the most part, peopled at a moderate density, and certain portions have a very sparse population. Our general conception of the North China Plain as densely peopled throughout is seen to be misleading. The Plain, although topographically uniform, is very varied from the point of view of soil conditions and habitability. There may be distinguished three or four distinct soil types:

1. Alluvium intermixed with loess, which probably constitutes the richest type.

2. Silt soils.

3. Sandy tracts of an infertile character, largely due to the deposits of the Yellow and Hwai Rivers, whose courses, as is well known, have frequently and disastrously changed (see Fig. 5).

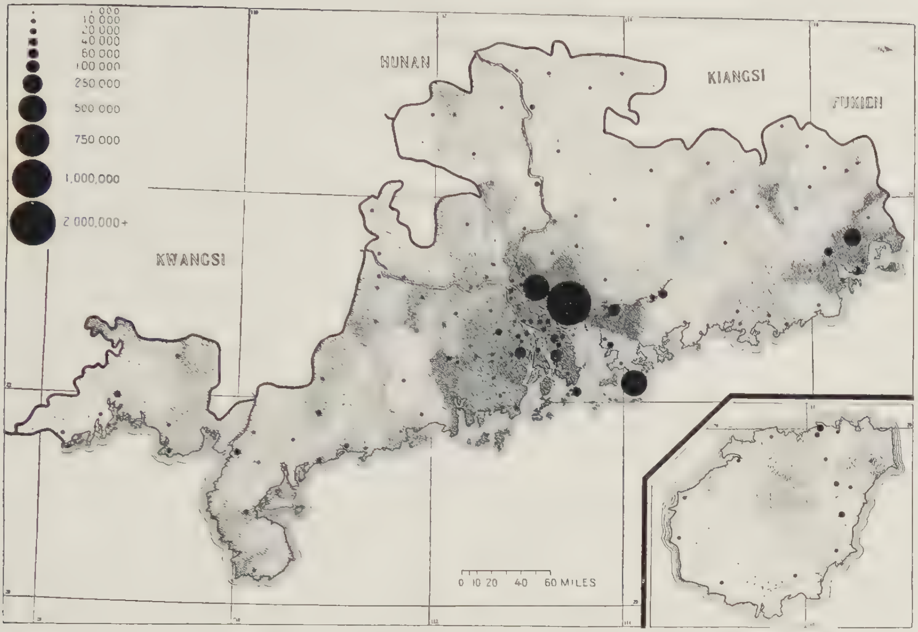

FIG. 8—Density of population in Kwangtung.

4. Large marshy areas, particularly around the Hwai River, imperfectly drained and liable to flood. A broad belt of sparsely peopled country is seen to separate the northern nucleus of dense population from that of the Yangtze Delta. This is the subregion of the Hwai Marshes, long a refuge for the "barbarians" after the rich lands around it had been effectively colonized by the Chinese.

B. The Yangtze Delta from Nanking seaward and including politically the southern third of the province of Kiangsu and the northern fringe of Chekiang. This region, in addition to its wonderful agricultural basis, is characterized by great industrial and commercial activity. The density of population reaches a maximum in the district lying to the east of the Taihu and between Hangchow Bay and the actual mouth of the Yangtze (including the Island of Tsungming).

C. The Canton Delta, although smaller in extent, is probably equal to the preceding in density. The concentration of population along the waterways, typical of Central and South China as a whole, is here displayed in its most characteristic form, although it is said that the recent construction of railways has to some extent modified it.

In these three regions—the Northern, the Yangtze Delta, and the Canton Delta—the density of population cannot be less than 1000 to the square mile.

D. The Red Basin of Szechwan, as a whole, is certainly less densely peopled than the three that have been mentioned. The density is probably about

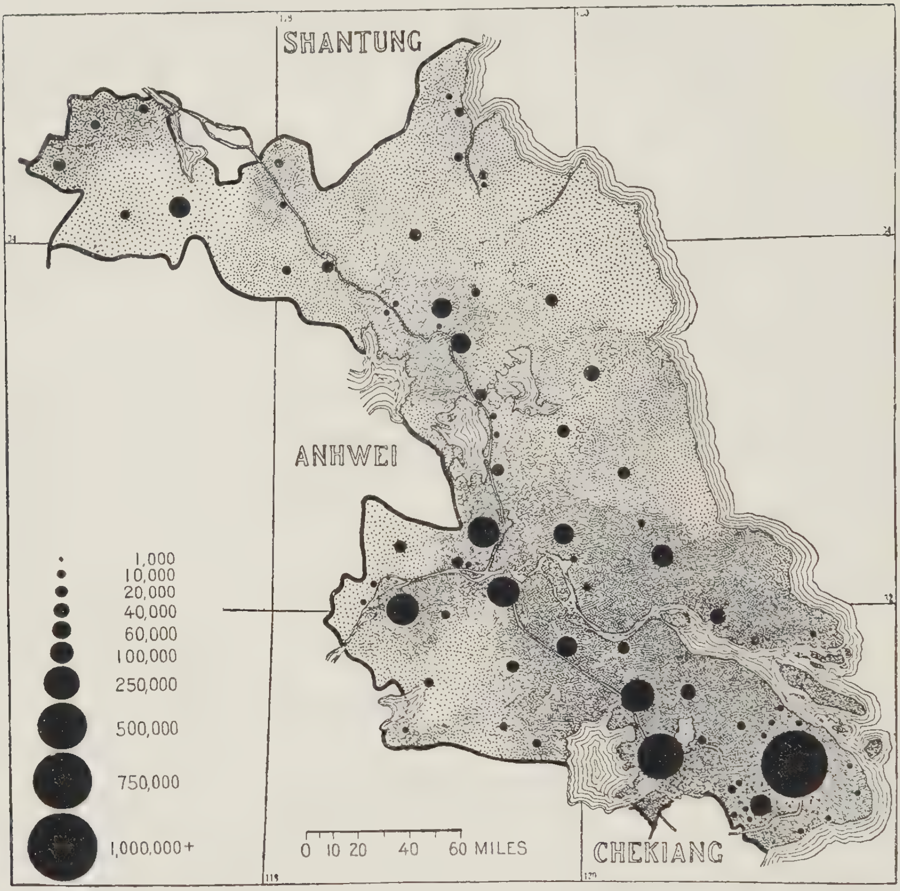

FIG. 9—Density of population in Kiangsu.

400 to 500 to the square mile. But in the subregion of the Plain of Chengtu, the scene of the most intensive irrigation in China, it is much higher and, according to one careful estimate, is not less than 1700 to the square mile.

E. The Coastal Fringe between the Yangtze and Canton Deltas. The dense population does not here form a quite continuous band. It is clustered round a large number of greater or smaller nuclei, such as Foochow, Amoy, and Swatow, but, as Figure 12 (Fukien) shows, the breaks in the continuity of the belt are not very considerable. It is an extremely narrow band, sharply defined by the thinly peopled maritime scarp of the South China Plateau; in a few cases, notably in that of the Min River of Foochow, the capture of the longitudinal drainage behind the maritime scarp by the working backwards of the coastal streams slightly extends its inland connections.

F. The Central Basin, or Basin of Hupeh. In this region are included the associated Basin of Kiukiang and the two great corridor valleys of the

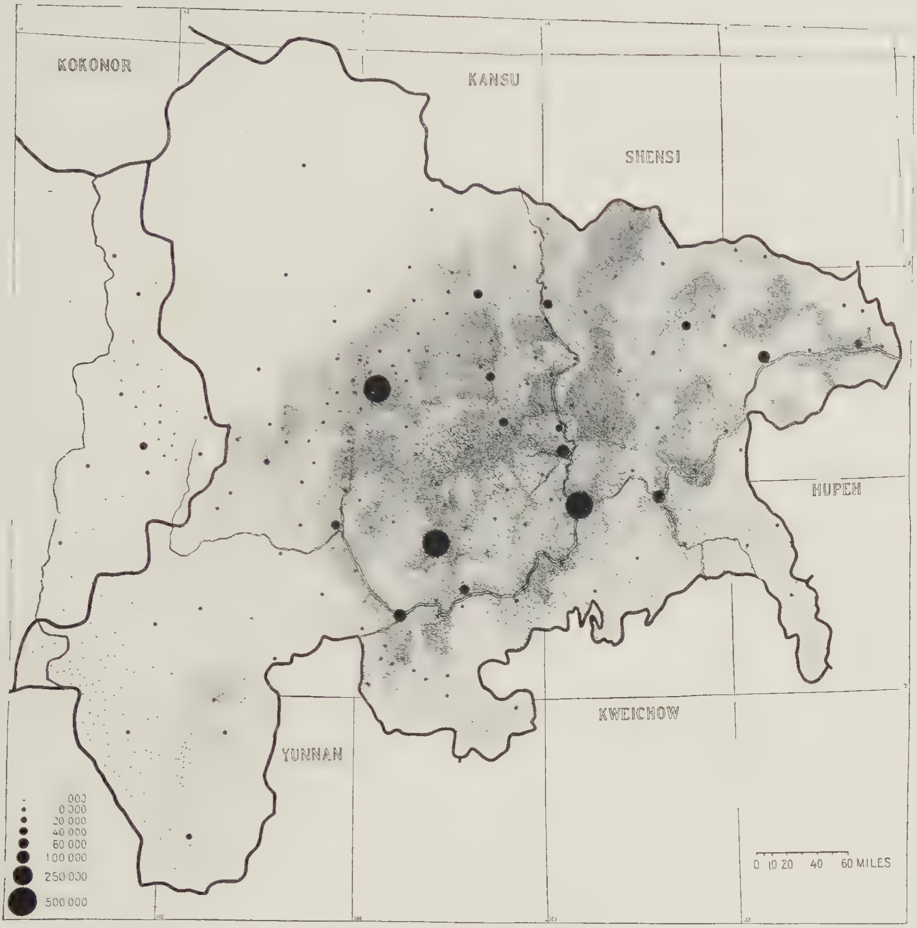

FIG. 10—Density of population in Szechwan. In regard to the western boundary it should be noted that in 1913 the western part of Szechwan with an adjacent portion of Tibet was constituted a special administrative district, Chwanpien.

Siang and Kan Rivers which give access from the south by way of the Tungting and Poyang Lakes respectively to the Central Basin and Yangtze Valley. On the northwest the valley of the Lower Han also belongs to it. It is a wonderful complex of converging valley routes, with Wu-Han (Wuchang-Hankow-Hanyang) at its center. It is difficult to give an average figure for the density of this "heart region" of China; but it is certainly not far behind that of the Red Basin, and it is probable that its potentialities have not yet been developed to the same extent.

So much for the regions of high density in China; they constitute only a small percentage of the total area. Elsewhere there are thickly peopled valleys, but in no other major region of China, with the possible exception of the Wei-ho Valley, is the population of more than moderate density. A brief survey of these must suffice to complete the analysis.

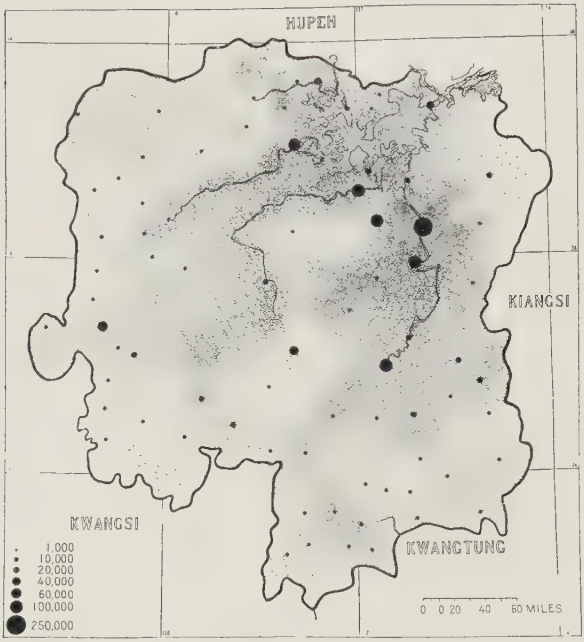

FIG. 11

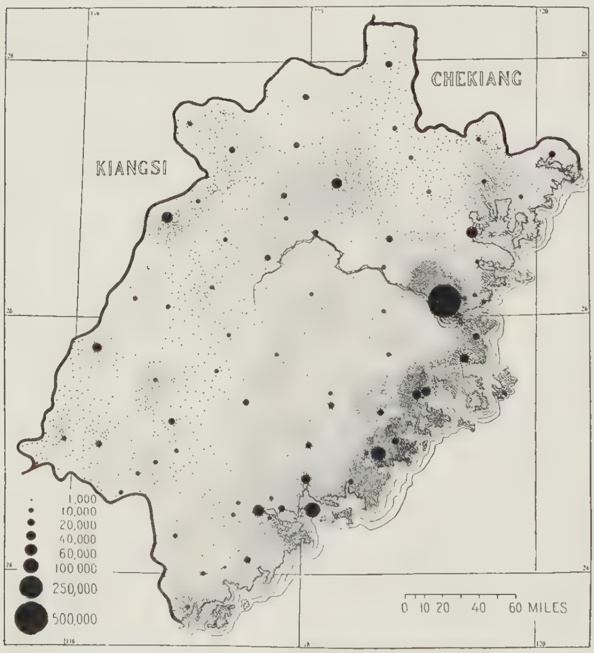

FIG. 12

FIGS. 11 and 12—Density of population in Hunan (Fig. 11) and in Fukien (Fig. 12).

The Loess Plateau of Northwest China, as illustrated by the map of Shansi (Fig. 13) shows a population of moderate density, much more evenly distributed than is the case in most parts of China and less related to the waterways. Even here, however, the population is thickest in the valleys. In them the fertile loess attains its greatest thickness and the valley slopes lend themselves to terrace cultivation. The typical position of a Shansi village is shown in Figure 17.[3] Cultivation on the exposed parts of the plateau is hindered by the devastating dust storms. Population attains its maximum density in the basins of the loess, particularly in that of Taiyüenfu, and in the valley of the Fen-ho.

The density for Shansi and Shensi Provinces according to the C. C. C. returns — respectively 182 and 121 to the square mile—is considerably lower than that of such typically rural English counties as Norfolk and Lincolnshire.

[3] Cf. illustrations accompanying the article by M. L. Fuller and F. G. Clapp: Loess and Rock Dwellings of Shensi, China, *Geogr. Rev.*, Vol. 14, 1924, pp. 215–226.

Agriculture is largely dependent on irrigation by wells (see Figs. 14 and 15), and, according to some authorities, its basis is becoming increasingly precarious owing to desiccation and the encroachment of desert sand. It is instructive to notice, as illustrating the small development of Chinese mineral wealth, that the famous Shansi coal fields make a barely perceptible showing in the population map of the province.

To the south of the Loess Plateau the Wei-ho Valley, the historic cradle of distinctively Chinese culture[4] and of great fertility, constitutes a small region of dense population. In an area of about 4000 square miles east and west of the great regional capital of Sianfu it has been estimated by one authority that there is an average of one market town to each square mile of territory.

FIG. 13—Density of population in Shansi.

The Tsinling Mountain Belt, which delimits the Wei lowlands on the south, is one of the most thinly peopled regions of China, a great barrier and a real cultural divide. The well peopled valley of the Han, although its upper and middle courses are in the same province of Shensi, belongs emphatically to the Central Basin, and the difference in physical type between its inhabitants and those of the Wei Valley is marked.

As for the Plateau of South China as a whole and the High Plateau of Yünnan the generalization is that the population is moderately dense in the valleys, which form only a very small part of the whole, and distinctly sparse on the uplands. Major Davies made a careful study of the distribution in Yünnan.[5] He estimated that in that province there were 140,000 square miles of highland and 10,000 square miles of plain. For the latter he estimated a density of 400 to the square mile, and for the former of only 40. This contrast between the relatively teeming population of the valleys and its sparseness on the highlands is eminently characteristic of China, and in the south and southwest it generally has a racial counterpart. The hill peoples are mainly aboriginal or pre-Chinese tribes, while the valleys are occupied by Chinese peasants.

[4] Cf. C. W. Bishop: The Geographical Factor in the Development of Chinese Civilization, *Geogr. Rev.*, Vol. 12, 1922, pp. 19–41.

[5] H. R. Davies: Yünnan: The link between India and the Yangtze, Cambridge, 1909.

Fig. 14

Fig. 15

Fig. 14—Well irrigation in the Taiyüen Basin (Province of Shansi) in the Loess.
Fig. 15—Irrigated land in the Taiyüen Basin.

Fig. 16

Fig. 17

Fig. 16—Cultivation on the floor and terraced slopes of a small valley in the Loess Plateau, Shansi.
Fig. 17—Typical position of a Shansi village.

It remains to emphasize the essentially rural character of the population of China. According to the usual estimate at least 80 per cent of the people are farmers or otherwise closely dependent on the land. Some careful estimates recently made indicate that only six per cent live in cities of 50,000 or over, another six per cent in towns or cities of 10,000 to 50,000, and the remaining 88 per cent in places of 10,000 or less. The fundamental social units of China are the farm villages (defined as having a population of between 250 and 2500 people) and the hamlets (defined as having a population of less than 250), and it has been estimated that in China there must be at least 100,000 farm villages with a total population of say 100,000,000 and at least 1,000,000 hamlets with a total population of say 200,000,000.[6] The hamlets are frequently clustered in satellite fashion round the villages.

In the Northern Plain and the Loess Plateau, so often in the course of Chinese history open to attack from the steppe land, the commonest type is the compact nucleated village, frequently walled. South of the Tsinling barrier, where there has been much greater protection, the scattered homestead is not uncommon, as in the Red Basin of Szechwan.

In connection with this subject of the general grouping of population, Figure 18, showing the distribution of great cities of 100,000 or over is interesting. It is frequently said that the cities of China are only overgrown villages. The statement is too loose. It is true of many of the smaller cities, which are often primarily market centers and have still a predominantly rural basis. But in the case of the large cities of 100,000 or over other factors enter in. The two largest *clusters* of great cities are in the Yangtze Delta and the Canton Delta, where industrial, maritime, and commercial interests have long been very active. On the other hand, the great Northern (Shantung) center of dense population, overwhelmingly agricultural in character, supports a much smaller number of great cities, while the province of Shansi has not a single city of the magnitude of 100,000. The significance of the two interesting lines of great cities south of the middle Yangtze is that they are transport and distributing centers on the two great corridor routes between the Canton Delta and the Central Basin.

Economic Aspects of the Distribution of Population

We are all familiar with the gloomy prophecies of increasing trouble to the world arising out of the "overpopulation" of China, and in truth the gravity of the problem cannot be gainsaid. But overpopulation is an elusive term. In what sense and to what extent is China an overpeopled country, and what are the essential factors in the future of the problem?

It is unquestionably true that certain regions of China are "supersaturated" and show unmistakable symptoms of overpopulation: a standard of comfort below the average of the Orient, a basis of life so insecure that any

[6] K. L. Butterfield: Education and Chinese Agriculture, China Christian Educational Association, Shanghai, 1922.

temporary failure of the crops, whether caused by drought or floods, is almost immediately followed by famine on a large scale with appalling mortality and misery as the consequence, and a constant tendency even in good times for the overflow of population. This generalization does not apply with equal force to all the regions of very high density discussed in the first part of this article. It is preëminently true of the Northern (Shantung-Honan) belt. Here the struggle for existence has long been intense.[7] It was from this region that the Chinese Labor Corps, which came to France during the war, was mainly recruited. There is also a steady overflow from this district of the Great Plain to Manchuria and Mongolia, in part representing a true colonizing movement but in part a temporary migration, thousands returning to their homes after the northern harvests. Recent investigations have shown that the rickshaw coolie class of Peking is constantly recruited from the surplus population of the Plain.[8]

FIG. 18 —Cities of 100,000 population and over.

The position in the Yangtze Delta seems undoubtedly better than in the Shantung belt. Here the chances of crop failure are much less, and there is a far greater variety of possible occupations. The phenomenon of over-population, however, is in this region most characteristically shown in the vast amount of cheap and exploitable labor available for the factories and mills which in recent years have increased very rapidly in Shanghai and its neighborhood, notably at Wusih. It is leading to the rise of a new and significant class in Chinese society, a proletariat, cut off from the old life with its well recognized social ties and moral sanctions, "adrift on the currents of an uncharted and troubled sea." There is perhaps no problem which more imperatively demands detailed investigation than that involved in the consequences on the social structure of China of the industrialization of her economic life. Similar phenomena are beginning to appear in Wu Han and other towns of the Central Basin.

Congestion is marked also in the maritime strip between the Yangtze and the Sikiang, particularly in the coast cities of Fukien. From this belt and also from the Canton Delta there is an outward movement of population

[7] See Tsing (Manchu) Government Records and Edicts, copious excerpts from which are given in a useful work entitled "The Economic History of China" (Columbia University, New York, 1921), by Mabel Ping-Hua Lee. Eighteenth year, edict: "In the provinces of Shantung and Honan whenever there is any bad year the people have to wander away and desert their homes because of famine and hunger" (p. 408).

[8] A detailed study of particular districts has recently been made in connection with The Famine Commission's Investigations and is published under the title of "The Study of Chinese Rural Economy," by C. B. Malone and J. B. Tayler (reprinted from *Chinese Soc. and Polit. Sci. Rev.*), Peking, 1924.

to the Straits Settlements, Malaya, Siam, and parts of the East Indies, leading to the growth of the important Chinese communities which are playing such a large part in the economic development of the Far Eastern tropics. They often retain a close connection with their ancestral provinces, and the supply of wealth which flows back to southeast China is an important ameliorating factor, as the foundation of the native Amoy University through the munificence of a former Fukien coolie illustrates. Partly owing to the favorable space relations which encourage emigration to regions where industry quickly brings rich rewards and partly as the result of its specially favorable climatic conditions and relative immunity from crop failure, the standard of comfort is unquestionably higher in the Canton Delta than in North China.

The position in the Red Basin of Szechwan is more difficult to state. As compared with the Northern Plain or the Loess Plateau, the risk of crop failure and of famine is relatively small; but, on the other hand, the isolation of Szechwan precludes relief by emigration, and there seems little doubt that the population relative to the means of subsistence is now so great that the standard of comfort falls below that of the average for China.

It is, therefore, true in the main that the richest regions of China are overburdened with humanity. But, on the other hand, it is certain that China, as a whole, could, apart from industrial development, support a larger population than at present, provided there could be initiated and maintained scientific and properly linked schemes of irrigation, water control, and afforestation. If certain regions are overpopulated, others through lack of public control are underpeopled. If the Yellow River problem in all its aspects could be tackled systematically not only would the risk of devastating floods be minimized but large tracks of alkaline soils in the Northern Plain, at present almost empty, could gradually be reclaimed.[9] Similarly afforestation would increase the productivity and extend the cultivable area of many parts of central and southern China. This would make possible a greatly needed redistribution of population which would for some time relieve the intense pressure on the more favored regions.

The carrying out of such schemes demands a degree of political stability and public confidence such as China has not known for many years. But beneath the political chaos, which is the phenomenon that has most attracted the attention of the outside world, there has been a steady growth of responsible public opinion directed towards such ends as these. It is being shown particularly in the growing solidarity of the merchant class,[10] in the formation of large associations, sometimes on a provincial scale, to foster economic enterprises, such as the Good Roads Movement, in sporadic ef-

[9] For the possibility of reclaiming waste tracts in the Plain of North China see an article entitled "A Striking Example of Scientific Farming in Chihli," in *Journ. China Philos. Soc.*, Vol. 1, 1911.

[10] The tendency of mercantile and commercial groups to combine on a larger scale is very marked in modern China. It is illustrated by the Federation of Chinese Chambers of Commerce and the influential Chinese Bankers' Association. It seems certain that the merchant class will take a larger part in Chinese politics and exercise a restraining influence on the militarists in coming years.

FIG. 19

FIG. 20

FIG. 19—The intensively cultivated Yangtze Delta, with characteristic dike.
FIG. 20—Scene on the congested Soochow Creek at Shanghai.

forts at afforestation, and in the eagerness of Chinese educators to introduce the applied sciences of the West. If some measure of political stability is restored, the economic progress of China will probably be very rapid, and the application of science to her agricultural needs will be one of its chief features.

But such a development, even if it leads to a considerable redistribution of population, will not by itself solve the problem. The ultimate cause of overpopulation lies undoubtedly in the social philosophy of the Chinese people which makes the begetting of posterity, irrespective of economic conditions, the fundamental obligation.[11] Unless and until there is some modification of that philosophy, neither a redistribution of the agricultural population nor the development of industry will be more than a temporary remedy.

This social philosophy, for which there was originally a strong geographico-economic basis and which is enshrined in and hallowed by the Confucian ethics, is of course very deeply rooted. It is still unquestioned by the toiling myriads of China as a whole, and at first sight there would seem to be little chance of any appreciable modification of it for generations to come. But two considerations deserve notice. The first is that the introduction of industrialism on Western lines implies the gradual dissemination of quite a new set of ideas and a new scale of economic values in some of the most "strategic" regions of China. The rapid development of strikes and similar phenomena, familiar to the West, in the Yangtze and Canton Deltas and in the thickly-peopled Coast Zone between them has been one of the most significant features of recent years. The conceptions and economic ideals of Western labor and, indeed, those of Bolshevik Russia are reaching not only the factory workers but all who come within the range of the new commercial influences. New forms of economic organization are coming into existence and along with them new, if still rather inarticulate desires for a higher standard of living.

Contemporary with these opening phases of industrialism is another movement in the realm of Chinese thought which may have far-reaching consequences, especially when it is more definitely related to the economic changes in progress. The Chinese Renascence, or New Thought Movement, as it is called, is primarily influencing the student body of China and has its center in the National University of Peking. It stands *inter alia* for a revision of accepted social canons when such can be shown to block the way of Chinese national progress, and some of its most distinguished exponents, with a large student following, have declared open war on the excessive cult of the family. Now it must be remembered in relation to all intellectual movements in China that they are liable to influence the masses of the people far more rapidly than in most Oriental countries for the reason that caste is unknown, that the constitution of Chinese society is in many respects

[11] Cf. the author's paper "The Far Eastern Question in Its Geographical Setting," *Geogr. Teacher*, Vol. 10, 1919–1920, pp. 82–90, 142–150, and 253–270, abstracted in the *Geogr. Rev.*, Vol. 12, 1922, pp. 138–139.

fundamentally democratic, and that the students are in fairly close touch with the masses of the people from whom they are drawn. The strength of the old ideas was largely due to the *literati* who expounded them. If China develops a new Intelligentsia consistently preaching a revised social code, the present conceptions of the people may be modified with comparative rapidity. More especially is this likely to be the case if the very genuine movement towards mass education ceases to be obstructed by military and political difficulties. It is, for instance, highly significant that in one province of China (Shansi) which, under wise and enlightened government, has been kept practically free from these troubles, provision has now been made for more than 60 per cent of the boys and a very high percentage of the girls to receive the elements of education in primary schools and that an appropriate literature on the needs and claims of modern Chinese citizenship has been compiled.

These considerations are not adduced in order to minimize the seriousness of the population problem in China, but to suggest that if wise measures of redistribution in China itself and the maintenance of adequate outlets for external colonization can keep it in check during the next half century, the solution may eventually be reached by spontaneous forces modifying the fundamental ideas of the people.

There is not space here to discuss the question of outlets for Chinese colonization. The population of southern Manchuria is now fundamentally Chinese, and they form the largest element in the north. But Manchuria is of course capable of holding a much larger population than at present, and there is the prospect of continued colonization for a long time to come in Mongolia round the margins of the Gobi Desert. This is the natural field of emigration from North China, but the extent to which it will be actually open must depend to a large extent upon Chinese relations with Russia. The political future of this vast area is very uncertain.

So far as South China is concerned, only some of the numerous lands which make up what can be called the Far Eastern tropics (in which I include most of Indo-China, Malaya, the East Indies, and the Philippines) are open to Chinese immigration, but there is no reason to anticipate any serious restraint on the outward movement from South China to this area as a whole.

Political Aspects of the Distribution of Population

The distribution of population analyzed in the first part of this article has an important bearing on the question of political consolidation. Will the civil wars and separatist movements of the last few years culminate in permanent dismemberment or will there be a consolidated Chinese state, whether on a centralized or federal basis? When we remember the vast and diversified area covered by China it is the cultural unity and not the political disunion that must strike us as the really surprising feature. Almost every-

where the same type of civilization prevails, the same fundamental ideas and institutions are found, and the same written language is used. The forces that tend more or less permanently to disrupt the peoples of a given territory or to prevent the growth of the spirit of nationality are, on the whole, strikingly absent. Although the Chinese are by no means a homogeneous people, there are no social or religious antagonisms comparable to those of India. The most important qualification of the general statement that in China regional religious antagonisms are not serious is that the large and fairly compact Mohammedan communities in parts of the western borderland may, under certain circumstances, constitute a menace.

FIG. 21—Distribution of languages.

Even the difficulties caused by the variety and number of the spoken languages can be overestimated. A study of Figure 21, showing the distribution of these languages, is illuminating. It will be seen that Mandarin, the official language, is spoken, with only dialectical differences, throughout practically the whole of the Northern Plain, the Loess Plateau, the Red Basin of Szechwan, the Central (or Hupeh) Basin, and the two great "corridor" provinces of Hunan and Kiangsi. In the coastal provinces from (and including) the Yangtze Delta southwards and in the Sikiang Basin there are a great variety of languages and sublanguages, reflecting largely topographical complexity and isolation.

In this southeastern and southern fringe the complexity is indeed bewildering. The sublanguages or dialects spoken include:

A. The Wu dialects of the Yangtze Delta and Chekiang. Of these there are about six main varieties, those of Soochow, Shanghai, Ningpo, Taichow, Kinhwa, and Wenchow—spoken by about 28 million people.

B. The Fukien dialects with about eight varieties. Each great valley or estuarine nucleus of population along the coastal zone, such as Foochow and Amoy, tends to have its own distinctive speech. The linguistic frontier between the various Fukien dialects and Mandarin coincides fairly closely with the high water-parting boundary between the provinces of Fukien and Kiangsi. The dialect of the large island of Hainan is an offshoot of that of Amoy. The Fukien dialects are spoken by about 24 million people.

C. The Kwangtung group comprises four or five main dialects, including the Hakka, spoken in the northern highlands of Kwangtung, the Swatow dialect, and Cantonese—the last being spoken by over 15 million people. In addition there are the numerous tribal dialects of the pre-Chinese peoples in the southwest (Kwangsi, Kweichow, and Yünnan), while the Tibetan

language extends over the border into Yünnan, Szechwan, and Kansu.

Great as are the obstacles to unity presented by this babel of languages in South China, it is to be noticed that serious efforts to overcome them are already beginning and that there seems to be a general disposition on the part of educators in Canton and other southern centers to work in conjunction with those of the northern and central provinces towards making Mandarin the *lingua franca* of China.

It is, however, the actual grouping of the great nuclei of population, in relation to the very inadequate means of communication at present existing, that constitutes the chief obstacle to understanding and unity. Three of these nuclei—those of the Northern Plain, the Yangtze Delta, and the Central Basin—are now in fairly close touch with one another. But the densely peopled Coastal Fringe is still almost completely cut off from the life of the interior. The Canton Delta has its own distinctive set of interests and virtually can only communicate with the Yangtze Valley or the North by sea. The Red Basin of Szechwan, with a population as large as that of the British Isles, is practically a world to itself, four weeks away—to express the separation in terms of time—from the peoples of the Yangtze Delta.

It is small wonder that these great centers, so remote from one another, should display separatist tendencies whenever the central authority exercised from Peking is weakened and that regional differences of economic interest and outlook should take a political form. But where there is, as in China, an underlying cultural unity, differences due to topographical isolation can be reduced and finally overcome by a systematic policy designed to remove or lessen the isolation. An improved system of inland communication is a prerequisite of Chinese consolidation. In particular the completion of the great Wuchang-Canton Railway, which would put the Canton Delta into direct continuation with Wu-Han and the Central Basin, is an urgent necessity. It would almost inevitably lead quickly to a much closer industrial relationship, through Canton's need of Pingsiang (Hunan) coal, and the establishment of an intimate commercial nexus would greatly reduce the chances of any permanent political separation. Similarly the building of the long-projected Szechwan railway from Wu-Han would tend to bring the great western province into the full stream of Chinese life.

In the task of consolidating China, the Middle Yangtze Valley, and particularly the Central Basin, seems marked out by nature to be the link and mediator between the great centers of the north, west, east, and southeast. Probably no other country in the world has such a wonderful nodal region as China possesses in the Central Basin of which Wu-Han is the heart. Here the greatest north-south trunk line (Peking-Hankow-Wuchang-Canton) will intersect the incomparable west-east waterway of the Yangtze at the head of navigation for ocean-going vessels. The great corridor valley routes from the south by the Siang and the Kan, from the southwest by the Yuen, from the northwest by the Han converge upon it. It is the point of contact of Szechwan with the rest of China, and the significance of this must soon

be immensely enhanced. Moreover, this great nodal or geographical center is nearly the geometrical center also.

Geographical considerations would certainly suggest that this region of the Yangtze below the Gorges ought to contain the organizing capital of modern China. In Yuan, Ming, and early Manchu times the appropriateness of Peking to serve this rôle is evident enough, and nothing need be added here as to the significance of its site at the northern apex of the Plain in relation to the bordering grasslands. The law of inertia will inevitably militate against change, and any proposal to transfer the capital to the Yangtze is certain to arouse the strongest opposition. Apart from vested interests, there is the sense of historical continuity to which the whole atmosphere and setting of Peking make a powerful appeal. Moreover, Peking has been deliberately made the chief railway center of China, and new economic significance is being given to its site by the development of the pastoral northwest through the construction of the Peking-Kalgan-Sui-Yuen line. Again, Peking is undeniably the intellectual capital of modern China, and most of the important new movements in the realm of Chinese thought have their center there.

These are strong forces and may well prove too powerful to be resisted. But if the creators of a united China make up their minds that one of the biggest factors in union is a national capital in as effective communication as possible alike with the Northern Plain, the great western province of Szechwan, and the commercial communities of the Yangtze and Canton Deltas, they are most likely to find it on the Yangtze below the Gorges—either at Wu-Han or at Nanking, a city with space relations not greatly inferior to those of Hankow and with historic traditions hardly less appealing, and more distinctively Chinese than those of Peking.

THE VALUE OF ALASKA

By Alfred H. Brooks
U. S. Geological Survey

[With separate maps, Pl. I, facing p. 50]

The average American of today has an entire ignorance of frontier life. We have become a sheltered people to whom pioneering is but a tradition and to whom only its dramatic side makes a strong appeal. We no longer think of it as an incident to future home-making. We forget that only half a century ago the great copper and iron fields of Michigan were in the wilderness of the "Northwest," where the Indians still formed a not insignificant part of the population; the prospector still traveled by bark canoe and made portages between watercourses; and remote settlements received winter mail by dog teams. The pioneers who first opened up the great granary of the Northwest had a vision lacking to their grandchildren, who nevertheless have greatly profited by that vision. Therefore, in appraising the value of Alaska, it will be well for us to view the land in terms not of our own experience but of that of our ancestors who landed at Plymouth or took part in the great transcontinental trek.

When Alaska came to the United States nearly sixty years ago, it was widely advertised as an arctic waste valuable only for its furs, a view that found apparent support in the history of the fur company which had monopolized the colony during the period of Russian control. In every industrial enterprise except fur hunting the company had lost out. Gold and coal mining had failed; no export market had been found for fish; farming had produced only a few potatoes; cattle raising had languished; even the shipping of ice to California was not a commercial success. During the eighty years of Russian occupation the land had yielded furs to the value of $45,000,000 but nothing else. The five hundred unhappy colonists had even to be supplied with food brought from central Siberia.

After the stir created by the transfer had subsided Alaska was forgotten again by all save the fur trader. Not for twenty years or more was public interest in the territory again aroused. This time it was over the scenic attractions: towering snow-clad ranges, magnificent glaciers, and superb fiords. Then the only public carriers were a few primitive packets operated to Juneau and Sitka. Now some ten thousand tourists make the trip each year in a dozen safe and comfortable steamers. By the new Government railroad the very heart of Alaska can be reached both comfortably and expeditiously.

The pioneer tourists who braved the discomforts of early travel brought back enthusiastic accounts of the country. Alaska became the happy hunt-

ing ground for the writer seeking "copy" during a summer vacation. A note on the wonderful scenery, an interview with a "pioneer" who had lived near the steamer wharf for fully five years, a few commercial statistics, and

FIG. 1—Wrangell, southeastern Alaska. Founded by Russians in 1832. (Photograph by G. K. Gilbert, 1899.)

the task was done. It was always possible to intrigue the reader by the novel statement that Alaska is not covered by snow and ice!

The mad Klondike stampede of a quarter of a century ago, when over fifty thousand gold seekers traversed the margins of Alaska, led to another phase —the heroic epoch of Alaskan literature. A majority of the adventurers failed in their quest; narratives emphasized terrible hardships, superhuman

efforts, and valorous actions. We cannot spare the true tales of endeavor and heroism which have marked the conquest of our last frontier, but they should be accepted as pictures of exceptional conditions and not of the

FIG. 2—Timber on the fiorded coast line of Southeastern Alaska. (Photograph by C. W. Wright.)

everyday life of the average Alaskan.

In more recent years another type of writers on Alaska found favor with the public. These, a by-product of the bitter conservation controversy, depicted the Territory as a place of untold riches, easily harvested, that were being seized by predatory individuals and corporations. This type of sensational writing, born of ignorance and prejudice, was, fortunately,

ephemeral; but it has had great influence in molding public opinion on Alaskan affairs.

Before the war the optimist held the stage, and innumerable official and private publications eloquently presented Alaska's tremendous resources and emphasized its vast areas open to settlement and home-making. Now the pessimist points out that little coal has been mined; that the oil resources are undeveloped; that the gold output is decreasing; that the salmon fisheries are depleted; that no pulp is manufactured; and that the population is declining. The post-war stagnation of Alaskan industries cannot be denied, and the unthinking interpret this as evidence of the final collapse of the Alaska boom.

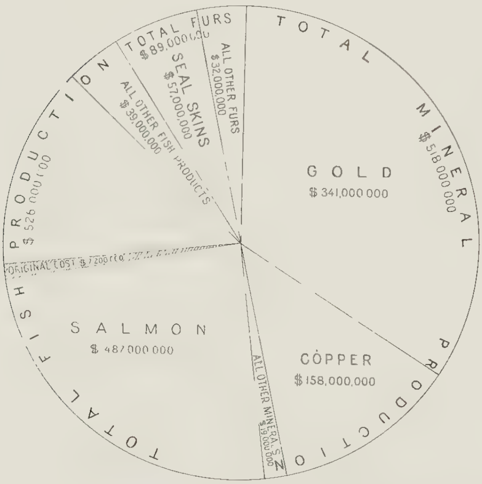

FIG. 3—Diagram showing the value of Alaskan products 1867–1923 ($1,133,000,000) in relation to the purchase price.

To the average layman the total expenditure on Alaska of about $125,000,000[1] including purchase price, appears a colossal sum for a territory including only about fifty thousand people. This amount covers a period of fifty-six years, and of this total $70,000,000 represents the cost of permanent improvements, such as railroads, wagon roads, surveys, telegraph lines and cables, lighthouses, and other permanent structures. Moreover, Alaskan industries have paid in cash into the U. S. Treasury more than $20,000,000, not including taxes; of taxes the Territory has borne its full share. If these permanent improvements and the original purchase price of $7,200,000 are charged to capital account, as they should be, and receipts are also credited, the actual Federal outlay for current expenses is $28,000,000, or about two and a half per cent of the value of the total Alaskan exports in minerals, fish, and furs.

It is the general practice to measure the value of a country by statistics of growth of population and commerce, because these are readily understood. But they are inapplicable to a new land, the future of which can only be visualized by an analysis of the facts revealing its inherent wealth. During the time that the public has derived most of its knowledge of Alaska from the dilettante, Federal exploration has gone on apace; and there has been gathered an enormous body of facts relating to her climate, minerals, fish, arable lands, forests, and other resources. It is the purpose of this paper to give a brief survey of our present knowledge of Alaskan resources.

[1] This does not include the cost of the building and maintenance of army posts.

Geographical Provinces

We shall first glance at the physical circumstances of the Territory. Thrust far to the northwest from America, Alaska lies close to Asia. Thus it is natural that the country was discovered and first settled by white men via Siberia. It was, indeed, the only part of the western hemisphere ever under Slavic control, and this for less than a century. Russia relinquished her American colony because of the administrative and defensive difficulties imposed by its isolation. The same factor has continued to make itself felt. From Puget Sound it is a journey of five hundred miles to the nearest Alaskan settlement, while the most distant one is three thousand miles away. Isolation, coupled with the fact that after the Civil War our nation became engrossed in the settlement of the trans-Mississippi region, explains in part the neglect of our northern possession. For nearly twenty years there was no civil government in Alaska; indeed, there was no government at all, except under the guns of the few army posts. It was not until we had acquired other oversea possessions and some experience in colonial problems that there can be said to have been any governmental policy for Alaska. Nearly half a century passed before Alaska was allowed any form of local government; its affairs being administered from Washington, five thousand miles away.

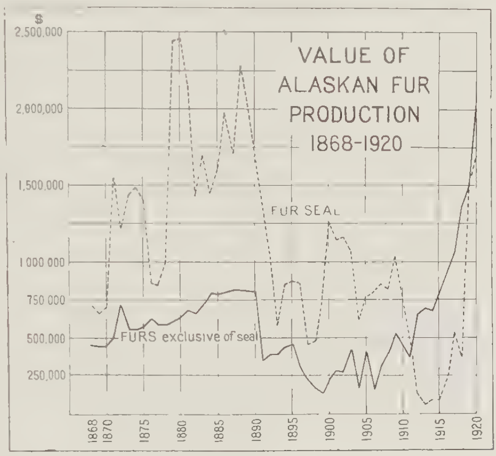

Fig. 4—Graph showing the value of Alaskan fur production, 1868–1920.

Besides isolation, great size is a factor to be taken into consideration. The dimensions of the Territory are of continental magnitude. This basal fact must be clearly comprehended by him who would understand the country. A traveler to the Gulf coast of Texas is not generally regarded as an authority on Montana, nor is the opinion of a visitor to the Atlantic seaboard sought on the needs of the west coast states. The wide range of climatic conditions in Alaska is due partly to a latitudinal extent equal to that between Mexico and Canada and partly to the temperatures of the oceans that wash Alaskan shores—the Pacific, warm and without ice even in winter; Bering Sea, cold and in part frozen in winter; and the Arctic, very cold and locked in ice for most of the year. But the greatest climatic influence is the distribution and altitude of the high ranges. As a result of these factors, Alaska's mean annual temperature varies from 10° in the north to 40° in the south, a range greater than that found within the United States proper.

FIG. 5

FIG. 6

FIG. 5—White birch forest and grassland, Salchaket Basin, Fairbanks district. (Photograph by F. L. Hess.)

FIG. 6—Grass on Cottonwood Creek, west side of the Susitna Basin. (Photograph by S. R. Capps.)

FIG. 7

FIG. 8

FIG. 7—Farm near Seward on the Alaska Railroad, October 20, 1918. (Photograph by Alaskan Engineering Commission.)
FIG. 8—Homestead in the Matanuska Valley.

Alaska may be roughly divided into three geographic provinces markedly different in character. The Pacific region is essentially one of high relief, diversified, however, by great valleys. Its precipitation is heavy, ranging from 60 to 180 inches annually; but heavy snowfall is mostly confined to the high mountains. Winters are mild, summers cool.

Inland of the mountainous belt is the Central region, all of comparatively low relief and with many broad lowlands. Its climate is one of short, hot summers and long, cold winters. Snowfall is very light in this region, and the

Fig. 9—Farm near Fairbanks. (Photograph by A. H. Brooks.)

total precipitation only from 10 to 20 inches. This inland region embraces about two hundred thousand square miles.

The third province, which may be rightly termed Polar Alaska, embraces about sixteen per cent of the Territory. The Arctic Mountain System completely separates it from the commercially far more important Central region. North of these mountains the land is of low relief and does not differ essentially from the circumpolar tundra or barren-ground region of the northern hemispheres. Its growing season is less than 40 days, and this accounts for its typically stunted vegetation.

The Fur Trade

It was the fur hunt that first drew Siberians overseas and for a century and a half engaged all interest in Alaska. The sea otter was the first prize of the Russian hunters, whose ravages and those of their American successors nearly exterminated this valuable fur-bearing animal. Fortunately, some of the species are still preserved and by strict protection may sometime again develop into a source of furs.

Extermination also threatened the fur seal but has been happily prevented by timely Governmental action. The first step taken, monopolization of the seal islands by leasing, did not prove strict enough, for the pelagic

sealers could slaughter seals indiscriminately on the high seas. This practice was finally terminated (1911) by treaty between the four interested powers—Great Britain, Russia, Japan, and the United States. At the same time the Government took over the sealing business under scientific supervision. When Alaska passed into our possession the Pribilof Islands were annually visited by over three million seal. Pelagic sealing had by 1911 reduced the herd to less than one hundred and twenty-five thousand. By protection it has now increased to six hundred thousand. The annual kill

FIG. 10—Ranch near Fairbanks.

is about twenty-five thousand, and the annual increase of the herd about five per cent.

Other Alaskan fur-bearing animals are also being protected so far as needed. As a region becomes settled the fur industry naturally decreases, but in Alaska it may be indefinitely extended by fur farming, which is greatly on the increase.

AGRICULTURE

It is still difficult to overcome the popular belief that the growing of food crops is limited solely by latitude. The Alaskan traveler sees the snow-and-ice-covered mountain heights of the Pacific seaboard; he is too apt to ignore entirely the vigorous plant growth exhibited by a vegetation of almost tropical density clothing the shore line and the lower three thousand feet of the mountain slopes. Even in the Russian days it was proved that potatoes, cattle, and the hardier grains could be raised in Alaska. The fur traders who guided the destinies of the colony left farming to a few ignorant peasants and exiles and, ignoring this local source of food, continued to draw all provisions from Siberia. For many years after our occupation, we followed the same policy of importing food at a heavy cost. In those days even resident Alaskans, chiefly gold miners, believed that the climate was too harsh

to permit of producing food crops. The earlier reports of Dr. C. C. Georgeson, who has devoted a quarter of a century to Alaskan agricultural investigation, were a favorite subject of jest.

Now all this has changed. Inland Alaska raises most of its own potatoes and root crops, as well as oats and other grains. The farmers at Fairbanks have ripened wheat for many years. During the war the scarcity of flour led to the grinding of wheat in a feed mill, and this in turn to the building of a small flour mill. Experience has definitely shown that tillage is limited not by climate but by local consumption; for, until economic conditions in Alaska have greatly changed, she cannot hope to compete in an export market. It is certain, however, that the time will come and in the not distant future, when pressure of population on this continent, as long since in Europe, will force utilization of the less desirable farming lands. In fact, the probabilities are that some of these northern lands will be used before much of that in the United States which requires heavy initial expenditures, such as costly drainage systems. The question is debatable; it should have serious study.

It has been shown that the southern two-thirds of the Territory, roughly bounded on the north by the Arctic Circle, has a different climate from that lying to the north, which is a truly Polar region. It is worthy of note that in Finland the Arctic Circle forms approximately the northern limit of general farming, though rye, barley, potatoes, and turnips are raised north of this line. Recalling Alaska's physical features, it will be noted that this southern two-thirds falls into (1) the southern rugged Pacific province and (2) the Central region with its more subdued topography. The high Pacific Mountains have no agricultural value; but the lower, including a part of the coast line and the larger valleys, possess both tillage and pasture land. The coastal belt proper has a growing season of 120 to 160 days and an average summer temperature of about 50° F., with a superabundance of rain. These conditions would already have promoted farming were it not that much of this area is heavily forested, and the land in general is of more value for tree growing. Beyond the limits of tree growing to the westward the Alaskan Peninsula and adjacent islands, as will be shown, have valuable grazing lands.

The most desirable agricultural lands of Alaska are in the Central region, now made accessible by the Government railroad. Here is an area of two hundred thousand square miles where the average summer temperature is 50° to 55° F. Incomplete records show that about half this area has a growing season of 70 to 105 days. These statements are very general, for they do not take account of local variations induced by topography, which must be determined by more detailed climatic records. It is probable that the regional and seasonal distribution of the small rainfall—10 to 20 inches—exercises a greater control on farming than do the temperatures. Those not familiar with the rapid plant growth during the long summer days of northern latitudes are reminded that this Central region has a

FIG. 11

FIG. 12

FIG. 11—Herd of reindeer near Teller Station, Port Clarence region, Seward Peninsula. (Photograph by William Hamilton, Bureau of Education.)

FIG. 12—Sled reindeer, Seward Peninsula. (Photograph by H. G. Kaiser.)

possible 18 to 19 hours of sunshine, which plays an important part in the rapid maturing of crops.

Alaskan soils have been but little studied or mapped, but the lands here classed as agricultural in general have favorable soil. Many have derided the possibility of agriculture in Central Alaska because below the thick mat of grass and moss the ground is perpetually frozen, and "obviously you cannot raise crops on ice." This frozen condition of the subsoil is a survival from a colder climate and has been preserved into the warmer climate of the present by the non-conducting moss cover. Removal of the surface mat of

Fig. 13—Purse salmon net. Southeastern Alaska. (Photograph by Bureau of Fisheries.)

moss and grass and cultivation cause permanent ground ice to disappear or to sink to a level permitting the growth of crops, as Dall pointed out in 1870. The presence of a frozen subsoil is indeed an advantage in furnishing moisture during exceptionally dry seasons.

The best of Alaska's tillable lands are in a zone directly served by the Alaska Railroad. Within a hundred miles of this trunk line there are over five million acres of prospective agricultural land. How soon this will be utilized depends on the development of other industries, chiefly mining, which will draw a population to consume the products of the farm. Even now there is room for farmers in this region, for the present scant population is not yet supplied with all the food that could be drawn from local sources. On the other hand, the outlook for any export of farm crops is not now promising. It has been suggested that the canning of vegetables and small fruits might prove a profitable industry, but this has not been proved by expert investigation. Sugar beets can be raised, but it is doubtful whether a sugar industry can ever be developed in competition with that of more southern latitudes.

Every Alaskan explorer has exclaimed at the luxuriant growth of grass throughout much of the Territory. Good meadows exist even north of the Arctic Circle, but the best pasture lands are on the Pacific seaboard. In the inland region the grazing season is usually only about a hundred days

in length, though some winter pasturage has been found in the driest portion of the Yukon basin. Under present demand, cattle raising in the Central regions, where over eight months of stall feeding is generally necessary, will be only incidental to mixed farming.

In southwestern Alaska cattle and sheep may be raised for the export market. It is hardly yet realized that there are about eight thousand square miles of luxuriant grassland on the Alaska Peninsula, Kodiak, and the adjacent islands, within fifty miles of tidewater, which is open to navigation throughout the year. Yet this is a land where the Russians raised

FIG. 14—Fish wheel on the Yukon. Automatically catches salmon. (Photograph by Theodore Chapin.)

cattle a hundred years ago. In favored localities there are perennial pastures, and feed for cattle and sheep is probably to be found in all of it for six to eight months of the year. The best method of utilization is not definitely determined, and the problem of winter feeding is not yet solved. The excessive summer rains are unfavorable for the curing of hay. Forage and root plants can be raised, and winter feed will probably be secured in the form of ensilage. The occasional bad winter will also require building of shelter—a heavy expense in a timberless region. One advantage of the southwestern pastures is that the mosquito pest is far less noxious than in the Central region. One has only to recall our depleted stock ranges in the Western States and consequent increase in the price of meat and leather to realize that this part of Alaska is an immediate national asset.

Reindeer Pasture

Thirty or forty years ago the Government imported some 1200 Siberian reindeer for the use of Alaskan natives. The descendants of these now number over two hundred thousand, in addition to the large number that have been slaughtered. Besides her cattle and sheep ranges, Alaska contains sufficient pasture lands to support several million head of reindeer. Much of this is too remote to be available except in the distant future. There is

extensive pasture in the Seward Peninsula where one company has about forty thousand head, from which it ships meat during the summer months. Some ten thousand square miles of pasture is to be found along the southern margin of the Alaska Range that is tributary to the Government railroad. It is estimated that at least fifty thousand square miles capable of supporting a million reindeer are now sufficiently accessible to permit of their utilization.

Timber Resources

The commercial timber of Alaska is limited to a part of its Pacific littoral, where the lower areas carry good forests, chiefly of spruce and hemlock, with some cedar. The best of this timber is in the Tongass National Forest of southeastern Alaska, and to a lesser degree in the Chugach National Forest on Prince William Sound. According to official records, these two reservations, roughly thirty-one thousand square miles, five per cent of the area of Alaska, contain about seventy million feet (board measure) of merchantable timber. Probably there are five to ten thousand more square miles containing merchantable timber in the unreserved areas of the Pacific province.

Extensive use is now made of the coastal forests in Alaskan industry. The demands of the war brought proof that Sitka spruce is especially tough and has high value for certain special uses. There is now a small export of this lumber. The Forest Service has estimated that the National Forests of Alaska may possibly be made to yield annually two million cords of pulpwood timber which would give a news print product equal to one-third of our present total annual production. As the Service reported many years ago that these forests were overripe, the immediate utilization of their annual crop would evidently be to the best interests of Territory and nation.

Alaska's inland forests cover some one hundred and fifty thousand square miles but consist only of a stunted open growth. This timber, while locally used for fuel and construction purposes, has no export value. An insignificant exception is some birch conveniently located to transportation, which may soon be exported for cabinetmaking. Even if found in tracts large enough to permit of use for pulp, these inland forests occur chiefly on frozen ground where growth is too slow to justify such procedure. Large areas have been ravaged by fires, and a good deal of timber has been cut for fuel. Much of the latter destruction could have been avoided if an unwise policy had not prevented exploitation of the superabundant coal. The burnt-over tracts, though involving a loss of timber, have at least enormously increased the pasture lands.

Fisheries

The Russians fed their distant colony extensively on salmon and indeed had a small export trade in the salted product, which was increased by their American successors; but it was not until 1878 that the first salmon can-

neries were built. The industry had a phenomenal growth during the last decade, culminating in 1918, when in response to war demands 135 canneries shipped salmon to the value of $50,000,000. The amount of food obtained from salmon in the war years is equivalent to that furnished annually by three and a half million head of cattle, for the support of which seventy million acres of natural pasture is needed. For forty years salmon has been the mainstay of the Alaskan fisheries and has indeed contributed

FIG. 15—Salmon cannery. Chignik, Alaska Peninsula. (Photograph by Bureau of Fisheries.)

over nine-tenths of the value of the five hundred million dollars' worth of fish shipped from the Territory.

Salmon streams are found along twenty-five hundred miles of Alaska's seaboard. Some spawning grounds of the fish are hundreds of miles up the rivers, and in case of the larger streams like the Yukon, two thousand miles from tidewater. Though hatched in fresh water, the young salmon finds its way to the sea during the first year, where it spends most of its life cycle. When two to five years old, according to variety, of which there are five, it returns to the parent stream and completes its cycle by spawning. The run to the salmon stream is preceded by the assembling of the fish in huge shoals near the shore line, and it is at this time that they are abundant enough to permit catch in large numbers. The largest salmon runs occur periodically, in two-year intervals separated by two years of much smaller runs. During the off season there is often not enough salmon caught to supply the canneries; while during the good season they are frequently over-

abundant. Though these cycles are fairly well established, they introduce an uncertainty into the industry. The wide variation in the size of the catch has at times led to a widespread belief that the Alaska salmon were threatened with total extinction. It is true that under the old law the salmon run became greatly depleted in some of the Alaskan streams, but the species as a whole are in no sense approaching exhaustion. The thorough investigations conducted by the Bureau of Fisheries show that there are

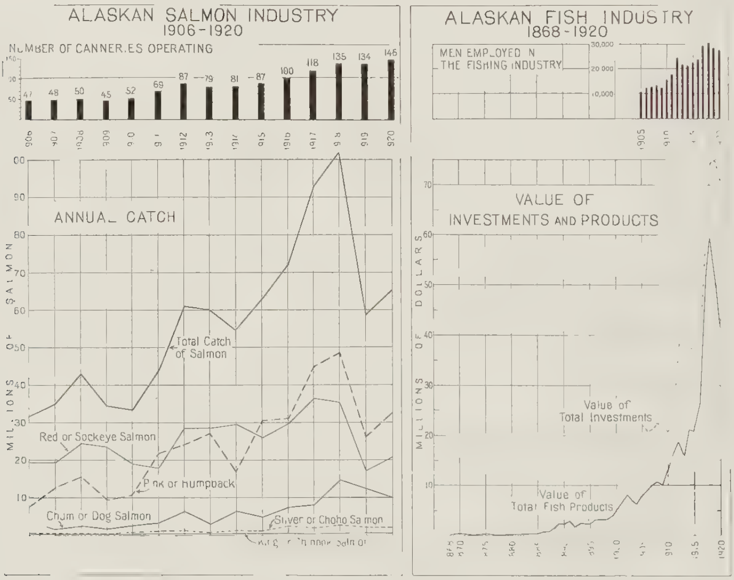

FIG. 16—Graphs showing the magnitude of the fisheries industry of Alaska. Figures for 1921 and 1922, respectively, are as follows: canneries, 83; 123: total catch of salmon, 37,905,591; 72,370,400: men employed, 15,070; 21,974: investments, $39,001,096; $54,590,302.

ample salmon to insure the perpetuation of the commercial fisheries under the restrictions of the new law.

The Alaska halibut fisheries have been overexploited, and there is grave danger of their exhaustion. As many of the halibut banks lie in international waters, they can be properly conserved only by international treaties. Herring are very abundant in the waters along the entire Pacific and Bering Sea shore line of the Territory. A continuation of the present large growth of the herring catch is confidently expected. The Alaskan cod fisheries, too, permit of a large increase of catch, in spite of the fact that they are the oldest of the Alaskan fisheries. American fishermen visited the Alaskan cod banks as far back as the Russian occupation: in fact, they were one of the chief reasons for the purchase of Alaska. There are also known to be many other varieties of food fish in Alaska, but these have been little used.

It was gold that first attracted men in large numbers to Alaska and for

many years has held them there. True that the records show more men engaged in fishing than in gold mining; but many of those employed in the salmon industry are brought in from the outside for the canning season only and have no permanent stake in the territory, while to the miner Alaska is his own land.

Gold and Copper Mining

The history of an industry may be written in terms of transportation. The first discovery of gold in Alaska revealed placers of such richness that a man single-handed could win virgin gold from the gravel with no equipment but pick and shovel. During this stage gold mining had this in common with the fur industry, that the necessary equipment and provisions could be sledded for any distance, while the value of the return cargo could stand the heaviest transportation costs. But while the fur cargo might be worth $70,000 a ton, gold was worth $500,000 a ton. And so during the bonanza period placer mining in the interior was profitable in spite of transportation difficulties. There have been instances in which the actual cost of freight has exceeded $500 a ton; but in the rich camps a ton of freight, consisting chiefly of provisions, produced $500 to $1000 worth of gold.

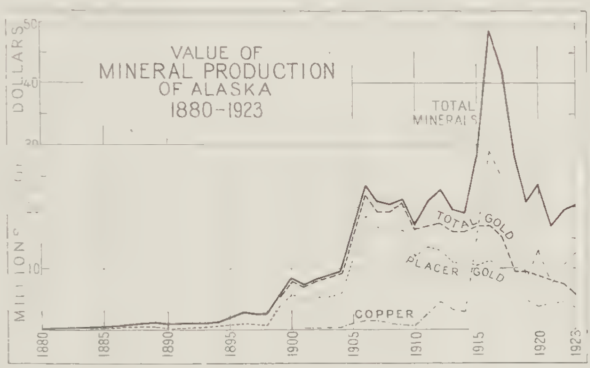

Fig. 17—Graph showing the value of the mineral production of Alaska, 1880–1923.

On the other hand, wherever heavy equipment and fuel are needed for placer mining, one ton of freight may be consumed for every $150 worth of gold produced. Compare these figures with the cost of other forms of mining. In copper mining a ton of freight will produce, say, ten or twelve tons of ore, the total value of which after it has been carried to some distant smelter may be not over $150. Still more striking is the relation of transportation to coal mining. Besides the cost of incoming freight, the product must find its market possibly at great distance, where it will bring only $10 to $15 a ton.

Twenty-five years ago, in the early days of rich mining at Nome, the average gold recovery was more than five dollars to the cubic yard, while in 1922 it was sixty cents. The same change has taken place nearly everywhere in Alaska. The average miner, digging with a shovel, can put into the sluice box about six cubic yards of gravel a day. If the gold value be only fifty cents to the cubic yard, his daily earning will thus be but three

dollars, and the venture will be unprofitable. If, however, the excavation be done with the use of a steam-driven machine or by water power, a single workman may perform the work of over two hundred, and placers may be profitably exploited that would be worthless to the pick-and-shovel man. Miners of the earlier days could afford to be uneconomic in their methods and stake their success on the discovery of new bonanzas. Now the engineer of a large placer plant watches his costs closely and determines in advance by careful prospecting the quantity of gold in the property. Placer mining on such a basis need have no greater element of chance than has many another business enterprise.

The future of placer mining in Alaska is determined by the amount of the gold reserves and the cost of its extraction. There is abundant evidence that there is more alluvial gold in Alaska than the amount thus far produced, which has a value of over $200,000,000. This estimate includes only placers having a high enough gold content to permit of successful exploitation by methods now in use, no allowance being made for the possible discovery of new auriferous districts. It does, however, include deposits to which at least wagon roads must be built before profitable mining can be carried on. There is no doubt that there are in Alaska large reserves of auriferous gravels, which will eventually be mined if the world continues to use gold as a standard of exchange.

The future cost of mining will be determined by general economic conditions, too large a problem to be discussed here. There has already been a local reduction in cost by railroad and highway building, for which reason alone a larger output of gold is to be expected. It is probable that the placer output has now reached its minimum; and if general economic conditions improve and approach the pre-war status, there will undoubtedly be a marked increase. No one can foresee when the change may take place, but probably not before five years. When it does come, we can count on at least a generation of prosperous mining on the basis of the estimated reserves. This mining, however, will not restore the pre-war prosperity brought about by bonanza exploitation.

All placer gold has been derived from the erosion of auriferous veins in bed rock, and its wide distribution in Alaska augurs well for the discovery of auriferous lodes in many districts. Indeed, gold-bearing quartz veins have been found in every one of these districts. Moreover, this expectation finds ample support in what is known of the geology of the Territory. Because of the greater outlay lode mining can only be successfully done in regions accessible to water or rail transportation. Of all the gold taken from Alaskan lodes, over ninety-seven per cent has come from mines located close to tidewater. It has been shown by long experience that these lodes in tidewater Alaska can be mined as cheaply as anywhere. Thus, it appears that the future of hard-rock gold mining in Alaska is limited only by the cost of transportation and by the ecomomic conditions that affect the industry throughout the world.

FIG. 18

FIG. 19

FIG. 20

FIG. 18—Pack train crossing Russell Glacier, in the Wrangell Mountains. (Photograph by S. R. Capps.)
FIG. 19—Hauling supplies up the upper Koyukuk by horse and scows. (Photograph by A. G. Maddren, 1912.)
FIG. 20—River transportation. The steamer *Tyrrol* with freight barges on the upper Yukon, 1904. (Photograph by L. M. Prindle.)

Alaskan copper mining, too, is in its infancy. Copper ore is widely distributed, and there are many deposits economically rich enough. Including mines and accessible prospects it may be said that there are about one hundred localities where there are copper bodies that promise to be of commercial size. These do not include localities now too remote to permit of development. All of the 518,000 tons of copper thus far produced in the Territory has come from localities served by railroads or steamers.

Most of the tin produced in North America has come from Alaska. There are also numerous other metals—platinum, silver, tungsten, antimony, chromite, and lead—of which Alaska has large stores. These, with her marble, gypsum, and sulphur, form an important element in the resources of the Territory. Iron, perhaps more important to the nation than any of the minerals listed above, also occurs in commercial deposits and quite probably in very large reserves.

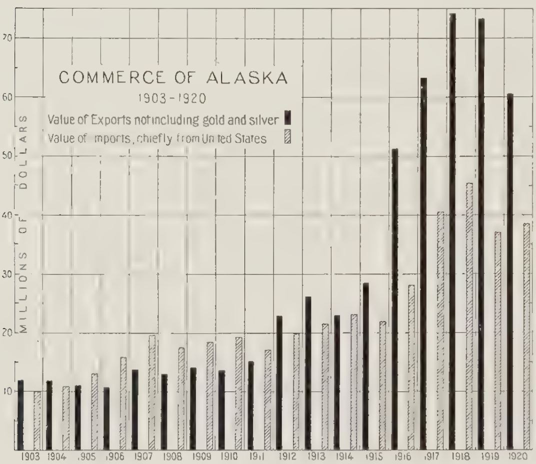

Fig. 21—Graph showing the value of Alaskan commerce, 1913–1920. Figures for 1921, 1922, and 1923 are respectively: imports, \$20,209,228, \$27,648,733, \$31,295,675; exports, \$36,916,924, \$51,082,995, \$54,878,426.

Sources of Power

Measured by its resources in power, Alaska compares very favorably with other parts of the world of equal area, for it contains large reserves of mineral fuels and of potential water power.

Coal, both bituminous and anthracite, of higher fuel value than any other of the Pacific slope, occurs in the Matanuska and Bering River fields. The first of these fields is tributary to the Government railroad, while the second can easily be made accessible to tidewater by railroad construction. There are other high-grade coals in less accessible parts of the Territory. The great bulk of Alaska's fuel consists of subbituminous and lignitic coal, and this is very widely distributed. Though only about thirty-five per cent of Alaska has been geologically surveyed, there are indications that the country contains at least thirty billion tons of coal, half of which is or can be easily made available.

An unknown part of the high-grade coals of the Matanuska and Bering River fields occurs in beds so folded and broken that they cannot under present market conditions be economically mined. The utilization of this deformed fuel must await a demand for such high-grade coal in the future, when its market value can meet the high recovery costs.

FIG. 22

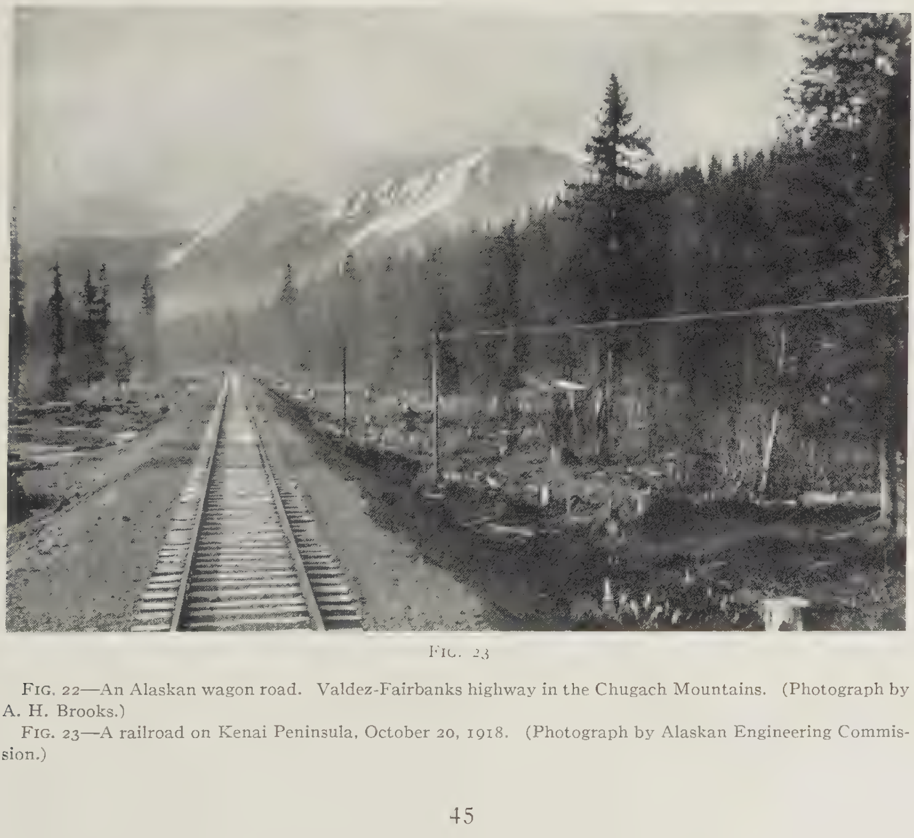

FIG. 23

FIG. 22—An Alaskan wagon road. Valdez-Fairbanks highway in the Chugach Mountains. (Photograph by A. H. Brooks.)

FIG. 23—A railroad on Kenai Peninsula, October 20, 1918. (Photograph by Alaskan Engineering Commission.)

The very abundant subbituminous coals of the Matanuska field, less deformed than the high-grade coal and therefore cheaper to extract, are now, thanks to the railroad, being profitably mined. These are being marketed for local use and are rapidly replacing imported coals which are of about the same fuel value.

There are five prospective oil fields on the Pacific seaboard of Alaska. In these the geologic structures and the presence of oil seepages encourage the hope of finding pools. In addition to these, two large seepages have been found near Point Barrow, the extreme northern point of the Territory. There is good reason to believe that petroleum may eventually be an important source of power in Alaska.

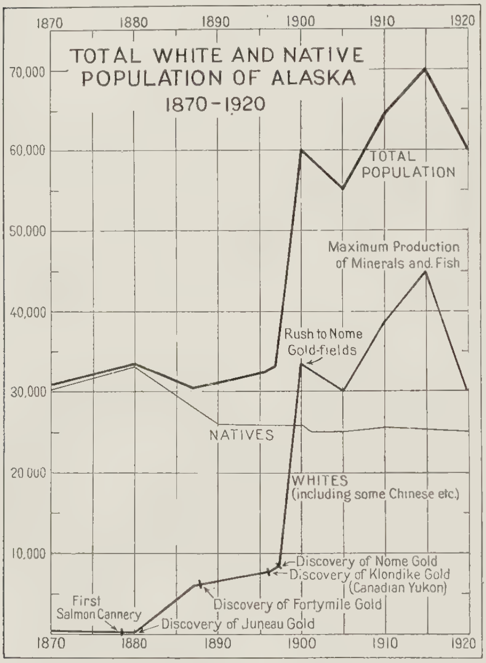

FIG. 24—Graph showing the numbers and composition of the population of Alaska 1870–1920.

Alaskan water powers have as yet been but little utilized. The use of water under head for placer mining is widespread in the Territory, and there are a few large water-power developments on the coast, chiefly installed for mining plants. Others are under consideration for pulpwood projects, while the use of small power plants by canneries and towns is very common. There is urgent need for Federal water-power surveys in Alaska. Evidence in hand shows that the Pacific Mountain region possesses large potential water powers, though many of these are so isolated that they figure only as ultimate sources of power, as do some of the vast coal fields of the Territory.

Utilization of Resources

In none of our possessions has Government policy so affected industrial development as in Alaska. This policy has varied from utter neglect to a paternal system of control more highly developed than in any other part of the United States. Even during the first twenty years of neglect, there were indications of Government supervision of Alaskan resources. This is illustrated by the attitude toward the seal herds of the Pribilof Islands, whose value was recognized even at the time of the transfer. As early as the seventies projects were launched for the utilization of valuable timber tracts in southern Alaska. These were ignored, although there was then no question

of conservation involved. Indeed, for thirty years no use of timber was legal except on a mining claim, and its export was prohibited until after the creation of the National Forest in 1909.

It was not until 1884 that the mining of gold and other metals was legalized. This did not discourage the gold prospector with his bonanzas; but coal mining, which requires large investment, is more sensitive. Plans made to develop Alaskan coal in the early seventies came to naught because

FIG. 25—A settlement on the fiorded coast line. View of Ketchikan in 1905. (Photograph by Sidney Paige.)

of the failure to give them any legal status. Coal-land laws were extended to the Territory in 1900, but proved inoperative because they applied only to subdivided lands, and no provision was made for surveys. A relief act was passed the next year but limited the granting of patents to tracts of only 160 acres, too small to justify the opening of a mine. In 1906 all Alaskan coal lands were withdrawn from entry and so remained until after the coal leasing laws of 1914. Thus they were only thrown open to development at the outbreak of the war, at a time when it was difficult to find capital for new projects. An unsuccessful attempt made by the Navy to find Alaskan coal available for its own use further discouraged the projects. As has been pointed out, however, there is much bituminous coal that can be cheaply mined now, and the present limit on mining is solely one of markets.

In 1901 petroleum attracted the first drillers, but this small oil boom soon collapsed because of the greater attraction of the more accessible California

field. In 1910 Alaskan oil lands were withdrawn from entry by Executive order and are still all in Government ownership except for a single small claim, to which patent has been granted, and here some oil has been produced. In 1920 an oil-leasing law was passed, since when drilling has again been revived.

During the time that her mineral fuels were barred even for local use, the Territory depended on wood and imported coal and petroleum. This amounted to about one million tons of coal, nearly five million barrels of petroleum brought from distant fields, and upward of three hundred thousand cords of wood. It is fair to estimate that there could have been a saving of some $20,000,000 if the local mineral fuels could have been drawn upon. It may be remarked parenthetically that this sum would suffice to pay over forty per cent of the cost of the Government railroad. The lack of cheap fuel also greatly handicapped all industrial development including the private railroad projects. The Copper River railroad was the only one that survived, and this because its immediate objective was an enormous body of copper ore.

Alaska was occupied for a whole generation before a settler could acquire any title to lands for farming or for business purposes. Colonizing projects were discussed long before 1898 when the right of homestead was first extended to Alaska. The present public land laws, though liberal enough for homesteads and for acquisition of business sites, have a marked tendency to retain ownership of all other lands in the Federal Government. As a result there is no Territorial land tax, for outside of incorporated towns there is little but Federal land. Indeed, over ninety-nine per cent of the area of Alaska is still in Government ownership. Federal and Territorial taxes are chiefly levied on the fishing industry and as licenses on large and small business enterprises.

Comparison of Resources

The future of Alaska cannot be evaluated solely by a comparison of her resources with those of the more favored and more accessible parts of our country. It is frequently asked "Why go to Alaska when we have much closer at hand the climate of California, the great wheat fields of the Northwest, the timber of Oregon, the iron and copper of Michigan, and the coal of Pennsylvania?" Such a question ignores the industrial changes which will be forced on the nation by increased population. Older parts of the world have long since been driven to use natural resources far inferior to those which our nation has so long enjoyed.

A journey to Finland would be an excellent prelude to an understanding of the future of Alaska. The Finlanders are a sturdy, progressive, cultured people, who have developed their high civilization under the most adverse climatic conditions and in a land but scantily endowed with natural wealth. Much of their crops are grown on land which in Alaska would not now be classed as having agricultural value. By industry, thrift, and application

of science, the Finlanders have overcome their adverse physical conditions and have made themselves a prosperous nation. The resources of Alaska, as far as known, of Finland, and of Sweden are compared in Table I.

TABLE I—COMPARISON OF RESOURCES OF ALASKA, FINLAND, AND SWEDEN

Resource	Alaska	Finland	Sweden
Area, sq. miles	586,400	144,250	173,550
Agriculture			
Farming and grazing lands, sq. miles	94,000	9,500	24,300
Cultivated land, sq. miles	9	6,000	19,300
Agricultural population	1,000	1,000,000	2,800,000
Annual production, cereals, tons	(1919) 140	(1905) 776,000	(1910) 23,389,000
Annual production, potatoes and other root crops, tons	(1919) 1,200	(1905) 446,000	(1910) 50,238,000
Reindeer pasture, sq. miles	150,000	8,000	40,000
Forestry			
Total area of woodland, sq. miles	190,000	79,000	82,000
Areas of good timber, sq. miles	35,000	61,000	?
Minerals			
Placer gold reserves	$200,000,000+	None	None
Lode gold reserves	Very large	Very small	None
Copper reserves	Very large	Very small	Small
Iron reserves	Probably large	3,600,000 tons	442,000,000 tons
Platinum, tin, chromite, antimony, mercury, sulphur	Commercial deposits	None	None
Marble	Large deposits	None	Little
Sources of power			
Total area of coal lands, sq. miles	2,000+	None	309
Probable petroleum reserves	Large	None	None
Total water power, horse power	2,800,000	1,500,000	3,500,000
Total developed water power, horse power	50,000	165,000	1,100,000
Fisheries			
Total export fish, 1913, tons	135,500	10,000	50,000
Communications			
Railroads, miles	765	1,900	7,000
Wagon roads, miles	1,030	27,240	38,380
Inland waterways, miles	6,000	3,240	900
Population			
Total	54,890	3,330,000	5,885,000
Per square mile	0.1—	23	34

Alaska has every advantage over Finland and Sweden both in food resources, measured by areas of arable and pasture lands and fisheries, and in potential energy, measured by water power and mineral fuel. Her metallic resources, with the exception of iron, which has not been sought for, are known to be far greater than those of the other two countries. Three quarters of Alaska has a climate entirely favorable to occupation by the white race and better than that of Finland and much of Sweden. On the basis of comparison with Finland we may look forward to the time when Alaska will eventually support a population of ten million people.

The nation has undertaken the task of making available to the people the resources of a land capable of supporting a large population. This can best be accomplished by placing no restrictions on the pioneer other than those demanded by the public interest and by putting at his service all the information obtainable by scientific investigation.

Under present conditions of her industries Alaska cannot, indeed, economically absorb any large population. The immediate need is to attract capital which will make her latent wealth available and thus give employment to labor and a market to the farmer. It should be observed that, as in most new lands, Alaskan financial ventures incur an element of risk that will deter capital unless there is also a probability of large profits. Neither settler nor investor will go to a distant land except with the prospect of bettering his financial condition. Some settlers will go to Alaska because of land hunger, for in all our history the acquisition of free lands has been a compelling force in the settling of a new country. As yet, however, we have no pressure of population to enforce the occupation of this, our last frontier.

THE TRANS-SAHARAN RAILWAY

By E. F. Gautier
University of Algiers

It is perhaps a little difficult for the American public to understand the importance to western Europe of the Trans-Saharan railway. So different are the relations between the desert and the mass of civilized white humanity on opposite sides of the Atlantic. In America the desert runs from north to south: to the south of the Mediterranean it runs from east to west. Everyone knows the fact, but it has certain consequences that are apt to escape general attention. Its effect is seen in such trivial matters as certain items of the American menu: in such tropical products as the grapefruit, banana, peanut. Of course this may be attributed to the American spirit of enterprise. But certainly that enterprise has nothing to do with the distribution of the catfish which is found in the Mississippi River and as far north as the Great Lakes. This tropical species is unknown in western Europe and in the Mediterranean Basin as a whole, with the exception of the Nile, an exception confirming the rule, for the Nile derives its waters from the tropics. Otherwise we must go as far as Central Africa to find this fish, which has no common name with us, being merely the *Clarias lazera* of the ichthyologists.

This instance, unimportant in itself, illustrates the interpenetration of climates which is the rule in America and which has other consequences far from trivial.

Cotton and sugar cane flourish in the Southern states, crops that a European would indubitably consider tropical. Yet one would not call the Carolinas, or Georgia, or even Florida tropical. The fact is that in America one hardly knows exactly where to draw the line between climates so clearly defined in the Old World.

The contrast is not peculiar to the Atlantic borderlands, of course. It obtains between all eastern and western coasts of the continents. In China, in eastern Africa, and eastern Australia likewise the precise boundary between tropical and temperate climates cannot be defined. On the western coasts of America, Africa, Australia, and on these coasts only, we find a desert at the point where the tropic reaches the coast. This desert, like a water-tight compartment, sharply separates equatorial and temperate. We approach a problem that cannot be discussed here—the law of distribution of the world deserts. But, whatever may be the general causes, the resultant fact is certain. In America the climatic zones interpenetrate. Blizzards on occasion carry their chilling influence southward even to Florida. The summers of New York have days almost tropical. The human consequences are important. Think of the place held by cotton in

FIG. 1—Map of northwestern Africa showing the route of the projected Trans-Saharan railway. The proposed short cut traversed by the Gradis expedition is also shown, and the route taken by the Algerian and Sudanese meharists in the junction recently effected across the Sahara. The map (scale 1: 20,000,000) is drawn from the "Croquis de l'Afrique du Nord," 1: 5,000,000, Service Géographique de l'Armée, Algiers, 1922.

the national life of America. And to the tropical cultivations of the United States came the tropical cultivator, the negro, an immigrant like the white man and now as enrooted, as autochthonous, as he. History has played its part here of course, but geography too and more so. The social attitudes of the Frenchman and the American towards the negro race are quite different. The roots of a collective sentiment are naturally multiple, and the question is complex: but one of the roots is certainly geographical. In the longitude of France the nearest country where the negro race can thrive is 3000 kilometers south of Marseilles and 2000 kilometers south of Algeria —2000 kilometers of frightful desert. Enrooting of the negro in France, even in Algeria, is as inconceivable as that of a field of sugar cane. The question has no ethnic importance: the negro in France is and always will be a curiosity. No need here for the white race to develop the defensive reflex known as "color prejudice."

At the base of all this is the Sahara. And these considerations may permit the American reader to imagine certain perspectives which the Trans-Saharan railway would open to western Europe. In America transcontinental lines unite New York and California—two states of the Union. In Africa the Trans-Saharan would unite Paris, Berlin, and Rome with the equatorial forest, surpeopled countries with underpeopled countries, manufacturing regions with sources of raw materials.

The Exploration

For the Trans-Saharan railway to be conceived as a practical idea the country had to be opened to exploration, that is pacified. In the last quarter of a century the task has been accomplished progressively, silently, inadvertently as it were. The workers have been three companies of meharists only the superior officers of which were French, perhaps twenty Europeans to a company. It would be exaggeration to describe their conquests as a work of war, they are rather a work of police.[1]

The initiator and guiding genius was Colonel, later General, Laperrine, beside whose name we must place that of the devoted monk Père de Foucauld. The task has been finished in the central part of the French Sahara to the south of Algeria, the Sahara of Ahaggar, and the Niger.[2] This is the Sahara now open to the writer, to the traveler, and also to methodical scientific exploration. But a great work of pacification remains to be accomplished in the west, in that part of the Sahara to which the general name of Mauritania can be given.

Recently public attention has been directed to the Augiéras mission, which has achieved a junction between Algeria and the Sudan across Mauri-

[1] E. F. Gautier: La conquête du Sahara, Paris, 1910.

[2] The Service Géographique de l'Armée has carried its mapping into the Sahara and has already published a number of sheets of the regions of Laghwat, Ghardaia, and Wargla. The most striking sheets are now in press. They give a topographical survey of the erg to the southeast of Wargla, and, I think, establish a record for the first precise contoured map of a great desert dune. It will be a unique document for the study of desert topography.

tania.[3] The farthest outpost in the direction of Mauritania is Beni-Abbès, a little palm plantation in the Wad Saura. It should be understood that the Saura is the dry bed of a Quaternary wadi, deeply cut and clearly defined but a fossil river. It is true that the head branches of the system lie in the High Atlas of Morocco and that two or three times a year at least waters coming down in flood pass under the windows of the post at Beni-Abbès. But this annual flood is insufficient to support any cultivation. The exist-

FIG. 2—At Hassi Inifel in Wad Mya, one of the largest of the Saharan wadis, a left bank tributary of the Igharghar west of Wargla. The wad is merely a line of verdure.

ence of the palm plantation is dependent upon an important spring. Beni-Abbès, on the border of the unknown, the point of departure for explorations, is today the scene of the greatest activity in the Algerian Sahara. It is the meharists of Beni-Abbès who are carrying out the pacification of the west. On the Sudanese side the counterpart of Beni-Abbès is found to the north of Senegal in Mauritanian Adrar, at the outposts of Chinguetti and especially Atar, the seat of a company of Sudanese meharists.

Both companies are ceaselessly engaged in the business of policing and exploration, and to both belongs much credit; especially to those of Atar, who have to work with inferior material. The native meharists of Beni-Abbès are white Saharians—Berbers and more particularly Arabs. Those of Atar are negroes. The negro is ill adapted to the life of the desert. He perspires greatly and needs to drink much, a grave handicap in a country

[3] Capitaine Augiéras: Mission transsaharienne Alger-Dakar (1920-1921), *La Géographie*, Vol. 39, 1923, pp. 1-35.

where the water must often be rationed. Moreover, he is a foot soldier and has to be taught to ride the camel.

The white meharists have been nomads from father to son for centuries; they are brought up on camelback and know no other horizons than those of the desert. All the faculties of these men, well endowed intellectually, have been consecrated to the interpretation of the least phenomena of the desert. Their skill in their craft is proverbial. To this marvelous human

FIG. 3—The market place at Tuggurt: in the center the mouth of an artesian well. Tuggurt is the terminus of the railway and starting point of an automobile service.

material belongs the credit of the great success quietly achieved by French policy in the Sahara in the last quarter-century: to the officers belongs the credit of taming and utilizing these semi-savages; and that is no small merit either.

Between Beni-Abbès and Atar as the crow flies are a thousand kilometers of desert without a single human settlement and without the possibility of creating one. There are some native wells, few in number and with limited water supply, the locating of which has been the work of the meharists. All the names on the maps pertain to these wells. They are utilized by the caravans going from Morocco to Timbuktu and also by marauding bands. It is a serious obstacle to communications but not the worst. On the most recent map[4] one will find a dotted line running straight between Rio de Oro

[4] Croquis de l'Afrique du Nord au 5,000,000^{ème}, Bureau Topographique du 19ème Corps d'armée, Algiers, 1922.

and the Adrar of Iforass, cutting slantwise across western Morocco. This line, corresponding in no way with the terrain, constitutes a terrible obstacle —a barrier of "red tape." It is the frontier between the two independent French administrations, of Algeria and of the Sudan, or more precisely French West Africa. The meharists of Beni-Abbès under their leader Captain Augiéras have, however, been authorized to make connection with those of the Sudanese meharists under Commandant Lausanne. It has been a triumph over administrative reluctance even more than over the desert. This first fraternization augurs well for the future.

Two sheets of the international millionth map recently published by the Service Géographique of French West Africa, Tidjika (1923) and Tombouctoo (1924), show that we have data for a sufficiently clear picture of the Sudanese Sahara. In an excellent sketch of the geological structure and physiography of Mauritania the late René Chudeau, geologist to French West Africa, has given an idea of the results being achieved by the meharists of Atar.[5]

The work done from Beni-Abbès has been summarized by Captain Augiéras.[6] Exploration is being continued and its results refined. Captain Ressot, successor of Captain Augiéras, has in hand an interesting geological study based on new journeys which probably will be published in Algiers by the Service of the Territories of the South.

We can safely say that the western Sahara can be visualized as a whole and in its entirety save for the coast zone of the Spanish territory, Rio de Oro, where interesting problems still await approach. Structure is simple. An old peneplain veneered over vast stretches with later deposits, red sandstone of Silurian and Devonian age, fine, hard Carboniferous limestones, and other red sandstones and limestones, much more recent, Cretaceous and Eocene. All these deposits, including the Silurian sandstone, are practically horizontal or very gently undulating. The relief also is simple. Almost at the center of the region rises a great dome of igneous rocks, mainly granitic, to a height of 600 to 700 meters, the plateau of Eglab. All around is an aureole of great dunes, the *ergs* of the Arabs, the erg Iguidi and the erg Ech-Chech enveloping the plateau with long tentacle-like arms. The region is dissected by river beds radiating from the Eglab or descending from the Moroccan Atlas, rivers of the Quaternary period. Today dead, their bodies still play an important rôle. They concentrate and carry off the water of the rare storms towards privileged spots where wells are found. Thus may be explained the two curious clusters of wells in the erg Iguidi, Wahila to the west and Menakeb to the east. Dangerous regions they are, fields of perpetual warfare between meharist police and marauding nomad.

These features are in nowise peculiar; they are duplicated in the central Sahara, of which the western region is only a prolongation. Yet the time

[5] René Chudeau: Contribution à la carte de Mauritanie, *Renseign. Colon.* (*Suppl. à l'Afrique Française*), Jan., 1912, pp. 20–27.

[6] Capitaine Augiéras: Le Sahara occidental, Paris, 1919; *idem:* Mission transsaharienne Alger-Dakar (1920–1921), *La Géographie*, Vol. 39, 1923, pp. 1–35.

FIG. 4

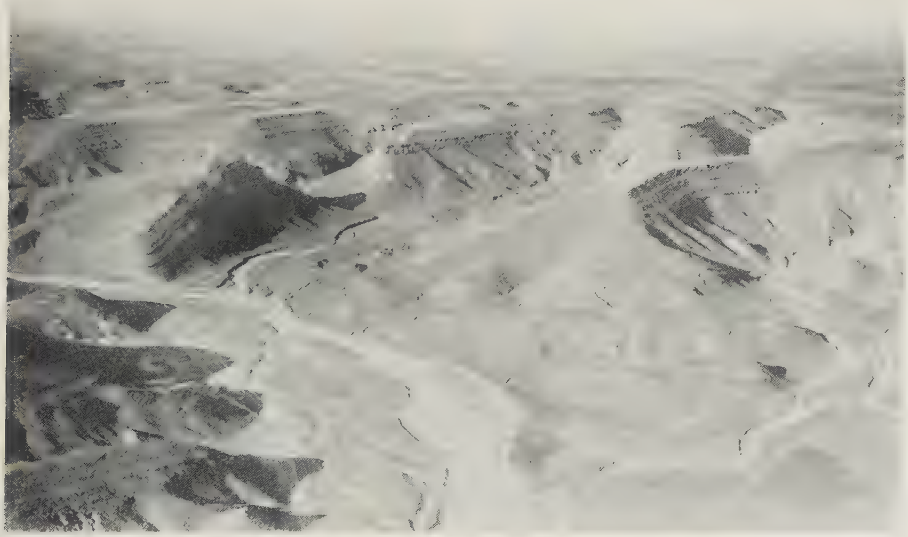

FIG. 5

FIGS. 4 and 5.—Ain Guettara, to the north of In Salah, on the automobile route between Wargla and In Salah. At this point the calcareous plateau abruptly declines in altitude: it has also been deeply cut up by the erosion of Quaternary wadis. It has been necessary to construct almost a regular road for the automobile route (Fig. 4).

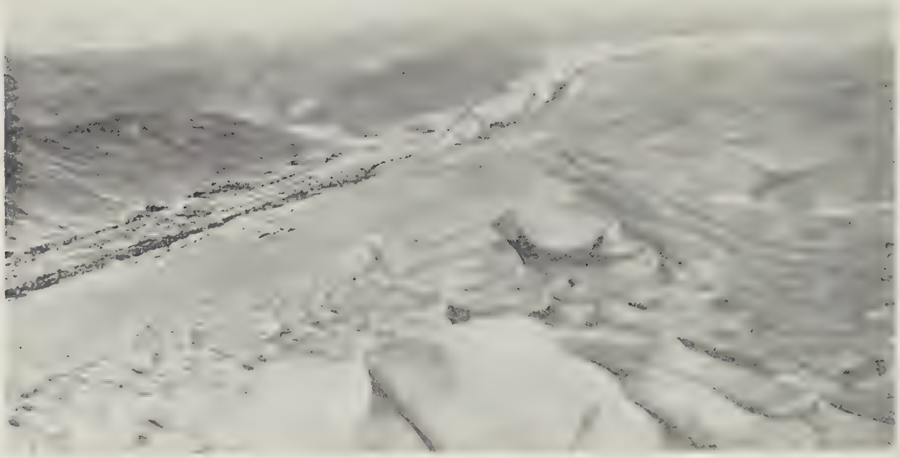

FIG. 6

FIG. 7

FIG. 6—Wad Saura, along which runs the projected route for the Trans-Saharan railway. Throughout its course it exhibits the peculiarity of being bordered on one side by the dunes of a great erg and on the other by rocky desert. The oasis seen is Kerzaz, to the south of Beni Abbès.

FIG. 7—In Salah, the most southerly of the Algerian oases, at the foot of the slopes of the Ahaggar massif. The village is enveloped by shifting sand dunes. To the right behind the palm plantation is a sheet of water of artesian origin.

Fig. 8

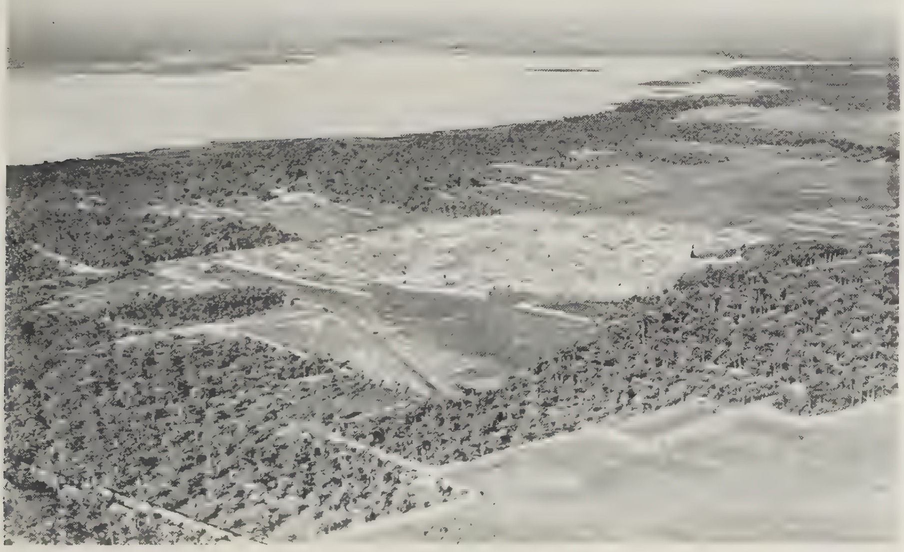

Fig. 9

Fig. 8—Oasis in the Wad Rhir, near Tuggurt. Irrigation is by artesian wells. The village is placed in the heart of the palm plantation, which before the coming of the French served a strategic as well as economic purpose, a vegetal fortification.

Fig. 9—Wargla. In the background a shott.

when the western region will be as completely pacified as the central is far distant. The essential difference between the regions lies in the human factor.

The scant humanity which the desert is capable of supporting is here concentrated on the fringes, on the southern slopes of the Moroccan Atlas and on the ocean border. The Atlas with its 4000 meters of altitude is a magnificent storehouse of water, even on the grilled face it turns towards the desert. Its waters support two luxuriant palm plantations, Tafilelt and Draa. On the coast, moisture from the Atlantic in the shape of mists and dew makes itself felt for a certain distance inland. The pastures it creates support powerful nomad tribes, that of Reguibat for instance. Certainly there is a connection with the Seguiet-el-Hamra, which played an important part in the history of Maghrab towards the fifteenth century. Unfortunately the Seguiet-el-Hamra belongs to the Rio de Oro, that is to Spanish territory. Tafilelt and Draa pertain to the Sultanate of Morocco. The meharists of Beni-Abbès and Atar have no right to penetrate these territories, which, escaping their vigilance, have naturally become the haunts of the raiders.

The Economic Aspect: Cotton

This explains in part why the central and not the western Sahara has been the chosen region for the Trans-Saharan projects. There is another and better reason. The routes through the central Sahara lead direct to the heart of Africa, and it is the heart of Africa that one wishes to unite with Europe. In this order of ideas the great event, or so it has been generally interpreted both in France and abroad, is the Trans-Saharan railway project adopted by the Conseil Supérieur de la Défense Nationale on June 11, 1923. The project is the building of a railway of normal gauge along a route already determined between the Algerian port of Oran and the bend of the Niger.[7] The most powerful of the French railway companies, the Paris-Lyons-Mediterranean, approached by the government, has accepted the responsibility of construction and has already sent out a reconnaissance party to make preliminary studies.[8]

This materialization as a government project has been a surprise for the French public as a whole, though the question has been long agitated and ardently advocated by many thoughtful individuals. Let us look over the events that have thus suddenly brought it to maturity. I think the most important, as usual, are of an economic order.

First note the simple fact that cotton at current market price at Alexandria is £40, in French money 2800 francs, a ton. "Central and western Europe do not produce 1000 tons of cotton a year, while the textile industry absorbs 2,500,000 tons . . . Of this quantity 1,500,000 tons comes from

[7] Details of the official project are contained in *L'Afrique Française*, Vol. 33, 1923, pp. 467–471.

[8] *Renseign. Colon.* (*Suppl. à l'Afrique Française*), April, 1924, p. 129.

FIG. 10

FIG. 11

FIGS. 10 and 11—Ghardaia, the chief town of the Mzab, seen from the ground and from the air. Compare Figure 10 with the plan of the city accompanying the note "Ghardaia: A City of the Desert," *Geogr. Rev.*, Vol. 14, 1924, pp. 476–478.

the United States."[9] The question arises as to whether the United States will continue indefinitely to provision the European mills. We hear much of the cotton crisis provoked by the recent shortages in the American cotton crop. It is a fact that post-war production shows a serious decline—1,500,000,000 pounds.[10] According to the U. S. Department of Agriculture Yearbook for 1922, the loss due to the boll weevil in 1920 was 20 per cent, in 1921, 30 per cent of the normal crop. But there is another consideration to be faced in the long run. The boll weevil will not kill American cotton: but the enormous development of the cotton industry in the country constantly tends to diminish the exports of raw cotton, and a day will come when the American mills will consume the entire production. There is nothing chimerical in the prospect.

England is paying more and more attention to the cultivation of cotton in her colonies. France does not feel the menace so keenly for she has no Manchester on her soil. Yet she imports on an average 250,000 to 300,000 tons of raw cotton a year, and her mills turn nearly 9,000,000 spindles. Supposing the need should arise, where could she raise the required amount in her own territory? Indisputably the answer is in the French Sudan.

Now in the French Sudan the cotton belt *par excellence* is the great bend of the Niger above Timbuktu. There is a vast region between Jenné and Timbuktu, easily recognized on the map by the network of swamps and lakes that cover it. This is the flood zone of the upper Niger inundated annually by waters from the distant highlands of the Futa-Jallon. A dike and an irrigation canal would extend the irrigable surface upstream to Bamako, thus giving a strip 650 kilometers long and 75 broad admirably adapted to cotton cultivation by its soil and climate. For long this has been described as a potential Egypt, and now a Nigerian committee is attempting to bring about a realization of the potentiality. An important step has recently been taken—the preparation by an official mission of the first precise and detailed irrigation scheme for the region.[11] The scheme has been actively criticized. We shall not go into the merits of the question: it will suffice to note the fact and the stir it has caused in France and its close connection with the Trans-Saharan project.

The future of cotton cultivation in the Sudan is naturally connected with development of ways of communication. The map, Figure 2, shows the state of railway progress in the western half of Africa between the Mediterranean and the Gulf of Guinea. Its most striking feature is the great number of short lines between Senegal and the Cameroons, in the English and French as well as in the old German colonies. They set out from the coast and proceed a short distance into the interior. It is a seaboard coloniza-

[9] Mission Bélime (1919–1920): Les irrigations du Niger: Études et projets: Résumé, Gouvernment Général de l'A. O. F., Paris, 1921, p. 33.

[10] H. M. Strong: Distribution of Agricultural Exports from the United States, *Suppl. to Commerce Repts.*, Jan. 28, 1924 (*Trade Information Bull. No. 177*).

[11] Mission Bélime (1919–1920): Les irrigations du Niger: Études et projets: Résumé, Gouvernment Général de l'A. O. F. Paris, 1921.

E. Bélime: Les irrigations du Niger: Discussions et controverses, Comité du Niger, Paris, 1922.

tion; the coast regions are naturally being developed first, slight progress having as yet been made in the interior. But French West Africa has long been considering the establishment of communications with the bend of the Niger. At first a mixed system was proposed; it was planned to utilize the navigable rivers, the Senegal and Niger, joining their navigable stretches

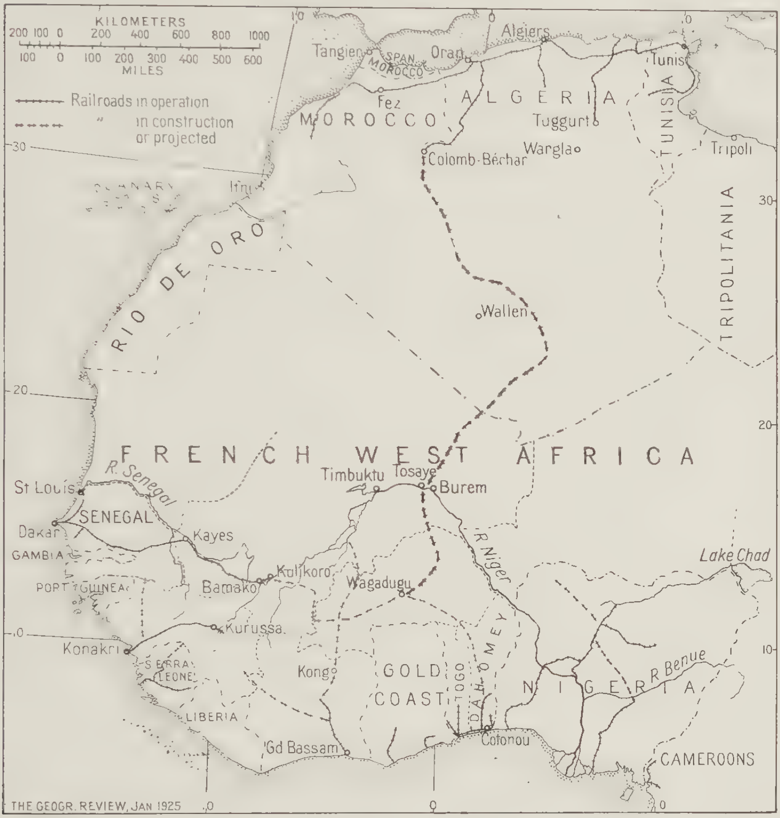

FIG. 12—Sketch map showing the relations of the projected Trans-Saharan railway and the North African and Sudanese railways. Scale approximately 1:37,500,000.

by rail. A railway from Konakri to Kurussa puts the coast into communication with the upper Niger. Along the route from Dakar to Kulikoro the Kayes-Kulikoro section across the watershed between the Senegal and the Niger has been built twenty years. Unfortunately, these two rivers are really navigable only in the wet season, six months in the year. This inconvenience, a serious handicap to all kinds of transportation, is prohibitive for cotton, which is picked in the dry season.

Experience has shown that the French Sudan will best be served by rail, a view towards which the government of French West Africa appears to incline. The Kayes-Kulikoro section has been connected by rail (1217 km.) with the port of Dakar, the line—begun as recently as August 5, 1923—having

been opened to traffic on February 1, 1924. It is too early as yet to see results, but they must surely be considerable.

It is planned to extend the railway net in the French Sudan with Wagadugu in the middle of the Niger bend as center. At the point on the coast nearest Wagadugu, that is Grand Bassam, the railway has already penetrated inland as far as the neighborhood of Kong. Furthermore, Wagadugu is the terminus selected by the official project for the Trans-Saharan. The project has encountered a certain amount of opposition in France. Each administration, each colony, has its particular scheme. In French West Africa they say, "Give us our railway network about Wagadugu and equip our port of Grand Bassam, and we can do the rest: we care nothing about the Trans-Saharan."

The great objection to the Trans-Saharan is obvious. From Oran to Tosaye, the point where the railway will cross the Niger, the distance is 2858 kilometers. It may be reduced by 300 kilometers. Even so there remains 2500 kilometers—a considerable distance for the transportation of cotton. It is true that Grand Bassam is far from the French mills, whereas Oran, the Trans-Saharan port, is only 800 kilometers from Marseilles. The Trans-Saharan engineers have calculated that a considerable part of the bend of the Niger would be interested in sending its cotton to Oran. I believe that they are right.

But there is another consideration which seems to me to have a determining weight—the character of the population. On this subject an anecdote is more eloquent than a dissertation.

An old man of Bagirmi on the borders of Lake Chad was recounting his reminiscences. "Not long since we were constantly raided by our neighbors, no matter of what race. All who resisted were killed or frightfully mutilated. The rest of us were carried off into captivity, rope round the neck, at least half dying on the way. When forewarned of the coming storm we would hastily take to the hills and cross them to seek refuge in the forest on the other side. But often we were pressed too close; then we were like hunted animals. We lost our heads, precipitating ourselves regardlessly over bush and rock. The fear-maddened women would tear off their jewelry, casting it behind in the hope of arresting the pursuit for a few minutes. And farther along, in the ravine down there, to quicken the pace they would, alas, throw the little children who encumbered the flight."[12]

It was the same miserable story whether on the banks of the Senegal and the Niger or on the Chad and whether the persecutors were of Rabat or of El Haj Omar or of Samor or of any other of these old empires that have succeeded one another in the past history of the Sudan. To this state of perpetual warfare, of which the slave trade was only the external symptom and issue, the French conquest put an end. The Sudanese people have readily adapted themselves to a state of peace; but the French conquest has only just been accomplished, and the effect of centuries of massacre is not eliminated in an instant. It is calculated that the population of the French Sudan on the average does not exceed three to the square kilometer; and this sparse population is very backward in economic development.

[12] *L'Afrique Française*, Vol. 33, 1923, p. 333.

The Sudanese is still a spade cultivator: he does not use the plow. For the last fifteen years serious attempts have been made to interest him in cotton cultivation. The effort has been practically wasted. The Sudanese plants millet and such green vegetables as are necessary to satisfy his immediate personal needs. Beyond that he will not go. The question of labor is the great stumblingblock to exploitation of the Niger bend. Assuredly its development can only be carried out by the use of agricultural machinery as in America, and this needs European initiative and capital. How can they be attracted? Will colonists from France go thither in sufficient number, making the long journey via Grand Bassam or Dakar and thence to the bend of the Niger? Would they not be tempted by enterprises nearer the coast? Colonists from Algeria would appear more likely. They hastened into Morocco as soon as it was opened to them. They would go to the Niger. And they would not go alone but would take with them native laborers and foremen. Since the war there have been 100,000 Kabyles in France, and they would just as readily go south as north. They would find on the Niger a country already inhabited by men of their race and language, the Tuareg Berbers. Without the help of Algeria I doubt if it would be possible to develop the Niger. This aid would be made certain by the Trans-Saharan.

The Military Aspect

Such is the economic side of the question, the fundamental though not the most obvious aspect. It is the Conseil Supérieur de la Défense Nationale that made the decision of June 11, 1923. Assuredly it sees the Trans-Saharan as the means of accomplishing the rapid and safe conduct of a black army to Algeria and France. Therein is betrayed the manifestation of a national inquietude, an apprehension of danger, a resolution to face it by all means. One cannot reside in post-war France without hearing the formidable noise of arms beyond the frontier. Yet this decision of the government to construct the Trans-Saharan has been a surprise for public, even for military, opinion. The public is uncertain that the financial burden to be imposed is the most urgent. Technical opinion is not agreed as to the military value of the measure.

It is impossible to review shortly these debatable matters. But a few facts bearing on the point may be indicated. The decision taken pledges only the government that took it. The Chambers have yet to be consulted. The project has been submitted to the Chamber of Deputies; but when it will be presented is not known nor the manner in which it will be received. The Paris-Lyons-Mediterranean Railway, while accepting construction of the line has stipulated for a delay of two years after the vote in the Chambers for study of the project on the spot. And, finally, after the vote in the Chambers and definite acceptance of the contract by the railway there will be the construction of the line. No one imagines it will take less than fifteen years. Probably more time will be required. Under the most favorable

FIG. 13

FIG. 14

FIGS. 13 and 14—Berrian (above) and Guerrara (below), which with Ghardaia constitute the Mzab group. These oases, irrigated at great expense, are insignificant points in the immense extent of absolutely denuded limestone plateaus.

circumstances, then, it will be twenty years before the first locomotive crosses the Sahara—almost a quarter of a century. That is a long time, especially in these days when things happen quickly.

Other Trans-Saharan Projects

In addition to the official plans, many private projects of a Trans-Saharan line have been put forward. Between Biskra and Tuggurt is a railway

Fig. 15—A closer view of Guerrara.

entirely in the desert, serving the region of Wad Rhir where are grown the famous Deglat-Nur dates. This line, which is in full working order, covers its expenses well and without doubt will be extended to Wargla; but it is doubtful if it could be pushed much farther.

The Berthelot project engaged serious attention in 1912. Instead of connecting with the Niger, this route, which has been called the Trans-African line, would go to Lake Chad and thence be joined up with the British Cape-to-Cairo line.

The Attack by Automobile

As it is, important results for Saharan communications have already been achieved by mechanical traction: the Sahara has been attacked by airplane and by automobile. The former had its moment of favor immediately after the war. Crossings of the Sahara by airplane were numerous:

unfortunately they terminated in a catastrophe. A last crossing cost the life of General Laperrine, who throughout his career had rendered such signal services to France in the Sahara. The airplane which carried him was wrecked in a remote corner, far from water and any form of help. He was found dead after long search. The Sahara, in fact, is not yet ready for great aerial flights, more sensational than useful. At present the airplane is most valuable as an auxiliary aid to the topographers.

The automobile is the form of transportation that has had the greatest success in the Sahara. The transformation in locomotion that it seems in the way of effecting had its beginnings in the war. Until 1914 the camel was without rival on all the desert roads. After the evacuation of Tripolitania by the Italian garrisons the natives, and especially the Senussi, more or less at the instigation of the Turks, invaded the French Sahara on the one hand, the Egyptian Sahara on the other. A side issue in the World War, the desert campaigns attracted little attention in the outside world though creating trouble enough for the local authorities. It was then that the automobile made its appearance in the desert. The war had momentarily suspended financial considerations: one spent prodigally without counting the cost. This particular piece of prodigality has strewn certain Saharan routes with the wrecks of automobile tires. Today, for instance, all along the route between Wargla and In Salah, they may be seen, looking like some strange desert vegetation. This new facies of the Saharan landscape has even been nicknamed in the Franco-Arabic argot: one hears of the *jenan* Michelin, the oasis Michelin—after the great French firm of tire manufacturers, of course.

The period of prodigal expenditure has passed, but the new method of traction has established itself. The automobile no longer belongs exclusively to the military and administrative authorities but to private individuals and companies. With Tuggurt as center regular services have been established, making the circuit several times a week between the Algerian and Tunisian oases—Laghwat, Ghardaia, Berrian, Wargla, Tozeur. They are utilized not only by European travelers but by the natives and do an excellent business.

It is, however, the great automobile ventures across the whole breadth of the desert that have special significance. The first, that of Haardt and Audouin-Dubreuil in Citroën cars in December, 1922, and January, 1923, has been described in a splendidly illustrated volume.[13] Towards the end of 1923 the feat was accomplished by the Gradis expedition under General Estienne in Renaud machines; and immediately afterwards came the second venture of Haardt and Audouin-Dubreuil. The success of these ventures fires the imagination. They accomplished in days what would have taken weeks on camelback. But what seems to me specially noteworthy about them is that they were not organized by public institutions, not even by

[13] G. M. Haardt and Louis Audouin-Dubreuil: Across the Sahara by Motor Car from Touggourt to Timbuctoo, translated from the French by E. E. Fournier d'Albe, New York, 1924.

geographical societies, but by automobile manufacturers or interested concerns. These successive ventures thus have the character of speed and endurance trials between competitors. Their authors, however, recognize the value of their expeditions for pure science. They have published their itineraries. That of the Gradis expedition, in particular, has been executed with a care that would be hard to match, longitudes being established by wireless.

Yet, in sum, these expeditions are only accessory to scientific exploration. Essentially they are industrial experiments. They aim at establishing a type of machine that is adapted to the desert terrain. The Citroën machines are caterpillar cars inspired by the tanks used in the war. The Renaud machines are six-wheeled after a new model. Each has its advantages and disadvantages. The caterpillar car is incomparable on the dunes and accidented ground; the six-wheeled car travels much more easily and rapidly over the great gravelly plains, the *regs*, which form a large part of the surface. The manufacturers are continuing to experiment, and their faith in the idea and its prospects is confirmed by the fact that both have bought considerable areas of land in the Niger region.

The conquest of the Sahara as an obstacle having been thus achieved, the objective of the crossings broadens in outlook. There is talk of a new expedition for the purpose of big game hunting in the Sudan, which, as is known, is one of the great game reserves of the world. The subject, too, has its interest for the moving picture companies.

At present the automobile appears as a collaborator with, rather than as a competitor of, the projected Trans-Saharan line. The first Citroën venture followed the eastern route through Tuggurt-Wargla. The Gradis and the second Citroën followed the western route by the Wad Saura, which in the interval had been officially selected as the route for the project. The Gradis expedition expressly proposed to seek a short cut which would reduce the length of the route by 300 kilometers. And it succeeded.

To the south of Wallen extends the Tanesruft, a desert within a desert, 500 kilometers without any permanent water. The desert trails and the original Trans-Saharan project go round it. The Gradis and the second Citroën expeditions crossed it with great ease: dunes figured on the map proved to be nonexistent; from end to end the machines rode over a hard flat plain of *reg*. Conditions are entirely dissimilar for animals and for machines. Five hundred kilometers without a drop of water or a blade of grass is a hard test for an animal, even a camel. On a good road a car can accomplish it in a few hours.

Exploration of the Sahara has been made on camelback: it can now be taken up from a new point of view. It would be imprudent to decide hastily on the route for a future railway. The aid of the automobile and the participation of financial and industrial concerns of high standing, in a word private enterprise, permit one to hope that the Trans-Saharan projects are viable.

THE KINGDOM OF THE SERBS, CROATS, AND SLOVENES

ADMINISTRATIVE DIVISIONS IN RELATION TO NATURAL REGIONS

By Borivoje Ž. Milojević
University of Belgrade
[With separate maps, Pl. II, facing p. 82]

The Kingdom of the Serbs, Croats, and Slovenes was created of territories formerly existing under a variety of political régimes: the independent kingdoms of Serbia and Montenegro; Bosnia-Hercegovina, annexed by the Austro-Hungarian Empire in 1908; Dalmatia, parts of Styria, Carniola, and some communes of Carinthia, pertaining to Austria; the autonomous Hungarian province of Croatia-Slavonia; and parts of Baranja, Bačka, and the Banat, pertaining to Hungary proper. The necessary administrative reorganization was provided for in the Constitution of the new Kingdom. In accordance with Article 95 the country "should be divided into regions by law, taking into consideration natural, social, and economic conditions." A time limit was specified, with provision that if the law were not passed in this time the Ministerial Council should be empowered to effect the administrative division by ministerial decree. As the National Parliament did not pass the law within the time limit, the division was effected by decree promulgated in the Sluzbene Novine (the Official Gazette) No. 93, of April 28, 1922.

By the above-mentioned decree the former departments of Bosnia and Hercegovina were made regions. Montenegro of 1913, with the district of Bocca di Cattaro, in Dalmatia, and without the departments of Pljevlje and Bijelo Polje, constituted one region. Dalmatia was divided into two regions, Split (Spalato) and Dubrovnik (Ragusa), formed by joining together existing political districts. Croatia, Slavonia, and Srem (Syrmia) were divided into four regions (the Littoral, Zagreb, Osijek, Srem) by the union of smaller administrative wholes—departments, districts, and municipalities. Kranjska (Carniola) and southern Stajerska (Styria) were divided into two regions, Ljubljana and Maribor. Baranja and the larger part of Bačka made one region, Bačka. The other part of Bačka and the Banat were made into counties by connecting them with regions in Serbia on the right bank of the Danube. In Serbia, within her boundaries of 1913, certain former departments were made into regions; others were constituted by the union of existing administrative units, departments, and districts. Altogether 33 regions (see map, Fig. 1) were constituted. Before commenting on this division we shall refer to the natural regions and population of the country (see Pl. II.)

FIG. 1—Map of the Kingdom of the Serbs, Croats, and Slovenes showing the administrative districts created in 1922 with the official centers.

Natural Regions[1]

The Adriatic Region

The Adriatic region is a narrow strip stretching from the Gulf of Fiume (Rijeka) in the northwest to the mouth of the Boyana River in the southeast. It is composed essentially of limestones (Cretaceous and Eocene) and marls and sandstones (Eocene), folded and faulted longitudinally. Sinking of the land has been effected along faults; but it is also due to the flexed folding of the whole country, by which process the lower or southwestern part was depressed, while the upper or northeastern part was raised. Numerous harbors, offering excellent natural protection, have been formed as a result of the movement of depression. Where important land routes converge upon such harbors, trading settlements have sprung up. Commercially they have been very active, especially at an earlier date. The numerous islands along the coast made possible an early development of

[1] See also Yves Chataigneau: La Yougoslavie, *Ann. de Géogr.*, Vol. 30, 1921, pp. 81–110.

seafaring, both legitimate trade and, in the early days especially, piracy. Fishing is developed, sardines being the chief catch.

The region has a Mediterranean type of climate and vegetation with characteristic production of vine, olive, and fig. The summers are dry and warm, the winters mild and rainy; the maximum rainfall, however, occurring in autumn and spring. Since the coast is bounded on the northeast by high ridges, large quantities of meteoric water are condensed upon them from the prevailing westerlies of the rainy season. Following the rains many springs and rivulets, dry in the summer, reappear. In order that the sudden rush of water may not wash down the soil the gardens are walled and terraced. In winter the barometric minimum tends to lie over the sea, while the barometric maximum overlies the cold mainland on the northeast. As a result of this difference in pressure a cold strong land breeze blows in winter from the land towards the sea. As it blows from the high mountain barrier, by which the coast is bounded on the northeast, this wind is not felt so much on the Dalmatian coast but is stronger on the Italian shores which in winter have the lower temperatures.

The character of the vegetation is influenced not only by dryness of the summers but also by lack of surface water over considerable areas in this typical karst country. The limestones are traversed by fissures. Chemical erosion by meteoric water produces such forms as lapiés and dolines.[2] The fissures broaden below into channels and lead to subterranean caves and passages. The water drains off vertically, and consequently a very small amount of water or none at all is left at the surface, although the rainfall is considerable.

In the limestone districts pasturages and shrubwood are rare and limited to fissures, where *terra rossa* has been formed. The flysch beds, however, are impermeable, and here we have surface drainage. By the weathering of these rocks a layer of soil is formed, possessing a luxuriant vegetation. On account of summer drought, irrigation is needed for some cultivations. Hydro-electric energy from the falls of the Krka and Cetina has encouraged a certain degree of industrial development.

The Dinaric Region

Inland lies the Dinaric region. Its northwestern part comprehends the long and relatively narrow upland zone of the *bilos* and *poljes*. The poljes have been formed by karstic and fluvial erosion. The wide areas between, the bilos, consist of parallel ridges and limestone coves. Although the rainfall is here considerable, the bilos as a rule are always dry. Water appears in springs on the border of the karst poljes. During the autumnal maximum of rainfall the lower parts of the poljes may be submerged, hence the villages are not situated in the central parts of the poljes but on their

[2] See Jovan Cvijić: The Evolution of Lapiés: A Study in Karst Physiography, *Geogr. Rev.*, Vol. 14, 1924, pp. 26–49.

rims. These flooded areas are given over to meadows, for the water drains off in spring too late for cultivation.

The cool summers of this region are due to high altitude, winters being cold and snowy. In the Pleistocene some of the highest peaks bore small glaciers. Such is the case, for example, with Šator and Cincer. Triglav, on the northwest and the highest peak, was the center of an intense glaciation, exhibited in the topography with its well developed cirques, troughs,

FIG. 2—The coast to the southeast of Dubrovnik (Adriatic region).

moraines, and fluvio-glacial terraces in the valley of the upper Sava. The altitude limits cultivation. In the poljes are meadows, pasture, and small areas of barley, rye, and oats. Every polje has its own town as an agricultural center. The limestone bilos afford pasture grounds. In the coves there are meadows. In summer the inhabitants of the poljes go to the bilos to mow and take thither their sheep. Here are huts for the shepherds and sheepfolds.

In the lower course of the Neretva (Narenta) River and southeast from it are the regions of Humina and Rudina. The former is characterized by conical limestone hillocks, the latter is constituted by low plateaus. These regions are composed of purer limestones (Cretaceous and Eocene). Here are seen poljes of a smaller size. Their bottoms are covered with alluvial deposits, while on the sides of the poljes and the lower ridges, which separate them, lapiés and dolines are developed.

The Humina-Rudina region is in proximity to the coastal zone and lies at a lower elevation. Here we have the characteristic summer drought

that necessitates transhumance. The village folk then take their sheep high up into the mountains to the northeast, where above the upper limit of the forest region are the summer pasturages, bringing them down at the beginning of the autumnal rains. Because of warm summers and mild winters, here in the vicinity of the seacoast, vine, tobacco, and the fig tree flourish.

To the northeast of Humina and Rudina lies the highest part of the mountainous Dinaric barrier. It consists of *povrshi* and *brda*. The povrshi are the elevated, extensive areas of limestones: the brda are ridges rising from the plateau surfaces. The povrshi are deeply incised by canyons, reaching a depth of several hundred meters, and are covered with dolines. From them rise ridges and ranges glaciated in the Pleistocene. In the cirques are snow masses, which remain there late into the summer. Here there is almost no vegetation, nor any abodes. On the elevated plateaus is pasture, scarce on the limestone tracts, but luxuriant on the morainic deposits. Here we have *katunes*, the summer abodes of the shepherds. The povrshi are here and there under pine forest, while in the valleys are deciduous forests.

In the valleys the underlying schists are often bared. They produce mild forms of relief and by weathering give rise to a layer of soil whence they are under a cover of vegetation. The milder climate of the valleys permits the successful cultivation of fruits and maize. The villages here are not migratory.

The Pannonic and Timok Basins

Between the Alps and the Carpathians is the extensive Pannonic basin, the site of a lake in Neogene times. In the Pontic stage this lake reached its highest level when it covered the lower valleys of the Morava and Sava on the southwest. Stages in the northward retreat of the lake are marked by a succession of steep banks or cliffs and shore terraces. These have been observed throughout the whole region that stretches from the Zlatibor and Stolovi Mountains (near the Ibar River, in southwestern Serbia) right up to the Sava and the Danube. In the valley of the Sava the lacustrine relief has been observed near Zagreb and Karlovats, in Croatia, while in the valley of the Drava it has been found on the eastern rim of Mt. Pohorje.

After the regression of the lake the rivers continued their courses across the dry lacustrine bottom and deepened their valleys. South of the Sava and the Danube the valleys slope towards the north, on which side they are open. The influence of the continental Pannonic climate and vegetation is felt far up the valleys. The valleys have also served as highways for the diffusion of central European culture.

East of the Great Morava, beyond the broad limestone barrier that stretches from the Danube towards the south, lies the basin of the Timok River. It was occupied by an arm of the great Neogene lake of the Ruma-

FIG. 3

FIG. 4

FIG. 3—The limestone country with sink-holes (dolines) to the southeast of Trebinye and Popovo Polje (Rudina in the Dinaric region).
FIG. 4—Cirque of the Kučki Kom (Dinaric region).

nian basin and hence has a terraced relief similar to that of the Pannonic basin. But the bottom of the basin consists for the greater part of volcanic cones.

The Timok basin is somewhat drier than the Pannonic border, since it is farther from the westerly source of rainfall. Opening towards the northeast, it is exposed to a cold wind, the *koshava*. The soil, formed by weathering of the volcanic rocks, is particularly fertile, and the basin itself is increasingly important agriculturally, with pastoral industry on the surrounding

FIG. 5—The confluence of the Sava and Danube (Pannonic region).

mountains. On the limestone barrier separating the Timok from the Morava basin, cattle raising is important.

To the north of the Sava and the Danube lies the broad Pannonic plain, the central portion of the Neogene lake, floored with thick deposits of sand and loam. The koshava, which blows here from the southeast, has built up considerable sand dunes, whose direction is southeast-northwest. Such is the case in the Deliblat and Baja-Subotica (Szabadka) sand areas. Here deep wells have to be sunk before water is found. In recent times, however, agriculture has been developed even in these sandy districts.

The lake sediments are for the most part responsible for the material to which the origin of the loess plateaus, both higher and lower, is due. The plateaus themselves are dry, and deep excavations have to be made before water is reached, which lies on impermeable clays. The loess plateaus are under wheat and represent the best wheat-growing districts in the country. The inhabitants are mostly agriculturists, and so the industry is also chiefly agricultural, gristmills being numerous. Agriculture ensures the great density of the population. But the products of agriculture serve also as food for cattle and sheep, and consequently the pastoral industry is progressing.

The large rivers meandering over the Pannonic plain are navigable, whence many towns are situated on their banks. The population of these

places may be engaged in commercial and industrial pursuits, as well as in various mechanical and other crafts, but very often agriculture and fishing are their chief occupations. Hence in many respects the towns resemble the villages. The villages of the plains and the loess plateaus are of a compact type.

Between the Sava and the Drava, hills composed of the older rocks rise from the plain like islands from the sea. Their slopes are covered by forests, which lend themselves to easy exploitation, and on the lower portions are

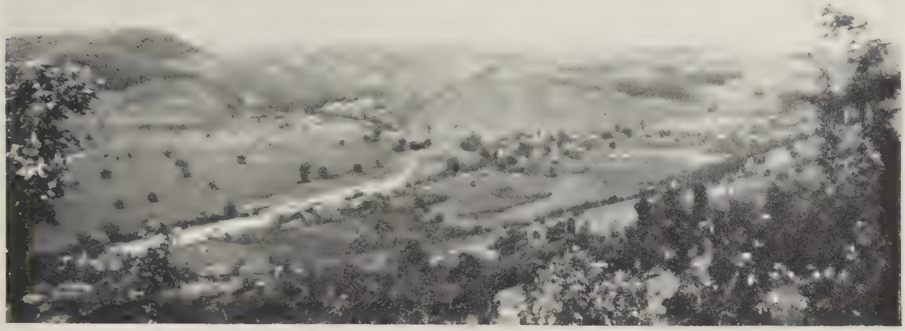

FIG. 6—A lacustrine platform in the basin of the South Morava (the southern rim of the Pannonic basin).

vine orchards. The Pannonic rim with more varied relief is more varied economically. Wheat is cultivated less, maize more, especially in the valleys. Large areas of forest have been cut down, and agriculture is plainly in the ascendancy.

The Morava-Vardar Region

South of the Pannonic border there is in the lower valley of the Morava an extensive region that stretches from the Jastrobac and Zhelyin Mountains towards the south as far as the northern rim of the Salonika plain. It is crossed by the upper Morava and the Vardar almost in a north-south direction and so may be called the Morava-Vardar region.

It is composed of a series of basins or troughs, dropped down between faults. In the Neogene they were occupied by lakes. All the lakes situated in the valley of the Vardar have been dried up or considerably reduced in size. Lacustrine deposits and terraces now remain. The lakes were connected with one another by outlets which were cut down more deeply as the lake waters subsided. The starting point of this lowering was the Vardar River, whence it spread to all the tributaries. Thus today we have basins connected by deep gorges or by cols, the ancient outlets of the lakes. These gorges permit the passage of Mediterranean influences in climate and vegetation from the Salonika plain to the north. In the basins north of the

Shar Planina and the Skopska Crna Gora (Kara Dagh) wheat and maize are cultivated. That is the case also in many of the higher basins south of these two mountains but to the west of the Vardar, for example in the basin of Tetovo. The basins round the Vardar, however, are lower, and the influence of the Mediterranean climate is here prevalent. Instead of wheat and maize we have here tobacco, vine, mulberry, and in marshy places rice.

On the mountainous horsts some forests have been preserved, but as regards man's economy their chief use lies in the broad pastures. Here the shepherds feed their flocks during the summer, at the beginning of winter taking them down into the plain of Salonika.

Population

The Density of Population

The density of population corresponds in general with the relief zones, the zones of least density coinciding with regions of greatest altitude, the compactly populated areas corresponding with regions of low relief.

The mountainous Dinaric region, which stretches from Triglav in Slovenia towards the southeast, in which direction it gradually attains its greatest width, is a region of minimum density. Here it is everywhere below 40 to the square kilometer (about 100 to the square mile). In the region of the elevated bilos and poljes the density, as for example in the district of Glamoč, is less than 15, and similarly in the region of the povrshi and brda, in the basins of the Piva and Tara Rivers. The lower bilos and poljes on the southwest, near Livno and Duvno, have a density of 15–25, while the low plateau in northern Dalmatia shows a density of 25–40. These regions are transitional between the poorly peopled bilos and poljes and the thickly populated coast districts. But the lower regions to the northeast of the mountain barriers in the middle courses of the Una, Vrbas, Bosna, and Drina Rivers, transitional in character between mountain and plain, have a greater density (25–40).

The density of population along the coast is greater than 40, in some parts reaching 70. On the Dalmatian islands it averages 55. However, along the coast there are two districts whose density of population is less than the average. Where the escarpments of the Velebit drop sharply to the sea the density is below 40, in places below 25. The other poorly peopled coast district is the marshy area at the mouth of the Neretva, where the density again falls below 40.

The lowlands on the northeastern side of the mountain barrier are also a region of greater density. Densities are similar to those on the coast. In the basin of the Sava the density is over 40 and in some parts reaches 70. In the middle course of the Drava, however, the density is less than it should be in this fertile plain. This is especially the case in the

southeastern corner of Baranja, between the Drava and the Danube. The anomaly can be explained by the existence of many large estates.

The most densely populated areas are in the upper courses of the Sava and the Drava and in the districts that lie between these two rivers. Here the density reaches 100 to the square kilometer (260 to the square mile), in

FIG. 7—Lake Petrsko on the southeast of Bitoly (Vardar region).

some parts exceeding that number. This is a result not only of highly developed agricultural and pastoral industries but also of mining and manufacturing: here is the richest coal field of the country, and considerable lead and zinc as well as iron ores are found here. The Pannonic plain between the Danube and the Tisa is also thickly populated, averaging somewhat below 100. The same agricultural region stretches east of the Tisa, but the density here is less—below 70 and about 55. This again is to be attributed in part to the number of large estates and in part to the marshy character of the undrained country.

A section cutting transversely across the valleys of the Morava and the Timok shows very clearly the reversed relation between relief and density of population. The hilly regions bordering the valleys of the Morava and the Timok, and particularly the mountain barrier separating these two valleys, are sparsely peopled; the lowlands of the two rivers are more thickly populated. The fertile basin of Nish shows a dense population. The same conditions obtain in the upper courses of the Morava and the Vardar,

where the mountain troughs or basins have a greater density, e. g. the basin of Bitolj (Monastir), over 55, and the Skoplje basin, over 40. The mountain blocks between the basins are much less populated, the density reaching below 40 and even 15.

The Ethnic Groups[3]

According to the census of 1921 the total population of the country amounted to 12,017,323. Of this number 9,974,110, or 83 per cent, are Serbs, Croats, and Slovenes.

The Serbs, Croats, and Slovenes were settled in their present lands by about the beginning of the eighth century of our era, having come from the plains east of the Carpathians. It was natural that as an agricultural people they should occupy the lowlands, plains, and basins suitable for agriculture. The earlier inhabitants, on the west the Illyrians, on the east the Thracians, retreated to the mountain regions, in time becoming assimilated and accepting the Slav language. On the west, in the Dinaric region, this process of assimilation went on throughout the Middle Ages. The Prokletiye Mountains (North Albanian Alps), stretching from Scutari in a northeastern direction, acted as an effective barrier against the southward progress of the Slavs. The present people of Albania are descendants of the ancient Illyrians. On the southeast, in the basin of the Vardar, there still exist small oases of Arumani, descendants of the ancient Thracians. They inhabit the mountains and are occupied in sheep rearing.

The South Slavs, settled in their present territories, were influenced by contacts with Mediterranean and Central European peoples. The coast population of Dalmatia participated during the Middle Ages in the economical and cultural development of the Mediterranean region as a whole. The people inhabiting the Morava valley on the southeast were open to the influences of the Byzantine civilization, as a result of which the characteristic Slav traits were weakened. Later on, during the Turkish rule, the people lived under the strong pressure of the feudal régime. The more recent cultural influences from Central Europe have contributed towards the material and spiritual progress of the population inhabiting the Pannonic region, especially the Slovenes. But all these cultural influences affected feebly the populations of the mountain districts, especially those of the Dinaric mountain barrier, which separates the coast from the basin of the Sava. Here the population have best preserved their traditions, both local and national, their customs, and language. The characteristic social forms, as for example the *zadrugas* (large kinship groups living under the same roof and cultivating their lands in common), and the tribal communities have also been preserved.

The South Slavs form one ethnic group, the unity of which is shown by the fact that their various dialects gradually pass one into another. With

[3] See also Jovan Cvijić: The Geographical Distribution of the Balkan Peoples, *Geogr. Rev.*, Vol. 5, 1918, pp. 345–361; M. S. Stanoyevich: The Ethnography of the Yugo-Slavs, *Geogr. Rev.*, Vol. 7, 1919, pp. 91–97.

the exception of the Slovenes on the northwest, the Croats and Serbs have practically a single spoken and literary language. The only difference lies in the use of the prevailing Latin alphabet on the west and the Cyrillic, derived from the Greek, on the east.

The other nationalities within the Kingdom comprise less than a fifth of the total population. Among these the Germans, Hungarians, and Rumanians live on the north and northeast, the Albanians and Turks on the southwest and southeast. The Germans and Hungarians settled in these parts mainly in the eighteenth century at the instigation of and supported by the Austro-Hungarian government. The Rumanians came down into the plain from the Banat Mountains, but many Rumanians immigrated here at the end of the eighteenth century from the present Kingdom of Rumania, where an oppressive feudal system then prevailed. Southeastern Jugoslavia was invaded by Albanians at the beginning of the eighteenth century, when these parts were abandoned by the Serbs, who fled from the Turkish yoke and in two great northward migrations crossed the Sava and the Danube. During the long Turkish rule many Turks settled in the Vardar valley, which served as an important route for traffic to the north.

The Religious Groups

The distribution of religions does not coincide with the distribution of peoples, but the geographic influences are evident. The Eastern Orthodox faith, coming from the Byzantine Empire on the east, occupies most of the regions to the south of the Sava and the Danube. On the east, as a result of the Serb migrations, it has extended well into the region on the left bank of the Danube, while on the west it has not reached the basin of the upper Sava. Out of the total number of the population 5,648,000, or 47 per cent, belong to the Eastern Orthodox faith. This faith is professed mainly by the Serbs and the Rumanians.

The Roman Catholic population is compact in the basins of the upper Sava and the Drava and next is well represented in the Pannonic plain. It is also strongly represented on the west in the coastal districts, whence it penetrated eastward. There are 4,687,000 Roman Catholics, or 39 per cent of the population. The faith is professed by Slovenes, Croats, Serbs, and Hungarians.

The Mohammedans include, beside the true Turks settled along the Vardar, a considerable proportion of Albanians and Serbs. The latter were Islamized during the Turkish rule. Mohammedanism is strongest in the districts which up to 1912 belonged to Turkey, and especially in Bosnia and Hercegovina. Thus there are two Mohammedan groups, the southeastern and the southwestern. The latter group shows the most northerly Mohammedan influences existing today in Europe. The Mohammedans number 1,322,000, or 11 per cent. The Evangelists are mainly the German immigrants.

The Administrative Divisions

In the administrative divisions as at present constituted strong religious and political party influences can be discerned. The Mohammedans of Bosnia and Hercegovina, nearly all of whom form a single political party founded solely upon religious grounds, have succeeded in embodying a clause in the Constitution according to which the former departments of Bosnia and Hercegovina become regions, and the combination of the various parts of the Bosno-Hercegovinian regions, whether within the boundaries of Bosnia and Hercegovina or beyond them, has been made very difficult. Thus the numerical relations between the Mohammedans and Eastern Orthodox in these regions have remained the same. Within the boundaries of the former Kingdom of Serbia the former administrative units have been largely retained by political influence. Although Article 95 of the Constitution provides that attention shall be paid to natural and economic conditions in subdivision of the country into regions, these have in fact been ignored.

On the west of the Kingdom, as already described, the coasts and their hinterland largely complement each other economically. This has naturally led to the interchange of products, though, because of the great barrier presented by the Dinaric Alps, commercial movement developed tardily —to the great disadvantage of both the coastal and inland populations. Such being the case it is particularly unfortunate that any man-made barrier should be allowed to intervene. Where coast and inland districts form an economic whole they should also be an administrative whole.

For instance, it seems most disadvantageous that the two coastal regions, those of Split and Dubrovnik, should comprise only the narrow strip of littoral. The Split region would benefit economically by the addition of a large part of the bilos and poljes of karstic Bosnia. These poljes are in active economic relations with coasts of Split and Šibenik, their exports going chiefly through these harbors, especially Split. On the other hand this part of karstic Bosnia has practically no connection at all with Travnik, now the central town of the region. The case of the Dubrovnik region is still more unnatural as it now consists of only a very narrow coastal strip. It should make one compact district with the Humina region of Hercegovina.

Apropos of the situation of Šabac on the lower Sava and of Belgrade at the confluence of the Sava and the Danube, Norbert Krebs remarked, "How much more active the traffic on both rivers [Sava and Danube] would be, how much more rapidly the towns on their banks would grow, if the rivers were not at the same time the frontiers."[4] And in another passage, having traveled across Serbia in 1916 at the request of and with the assistance of the Vienna Geographical Society and the Vienna Academy, he reiterates the same opinion.[5] In the first-mentioned work (p. 697)

[4] Norbert Krebs: Serbien und der serbische Kriegsschauplatz, *Geogr. Zeitschr.*, Vol. 20, 1914, pp. 689–701, reference on p. 695.

[5] Norbert Krebs: Beiträge zur Geographie Serbiens und Rasciens, Stuttgart, 1922, p. 20. Reviewed in this number of the *Geographical Review*.

Krebs points out how the small towns of Focha, Gorazde, and Vishegrad in the Drina valley "are in a better position to make use of their region from a transport point of view," because the frontier between Austria-Hungary and Serbia did not in this case follow the Drina, "than the places situated on the middle and lower Drina," where the frontier follows the same river. As the political frontiers on the lower Drina and Sava, as well as on the Danube, have now been abolished it means that the towns on these rivers will be fully able to carry out their natural functions, becoming transport centers for districts on both banks of the rivers. When the districts on either side of a river have one and the same economic center and compose a complete transport system they should constitute an administrative whole. But by the new administrative division this has been effected only in the case of Belgrade and the Danubian region. The river Drina, for instance, has continued its old rôle as a boundary between the counties of Bosnia and those of Serbia, while the Sava separates the regions of Bosnia and those of Slavonia. The towns along the Drina and the Sava are economic centers for the population living on both banks of the rivers, but they are not also their administrative centers. Such examples occur also on the Danube, Vrbas, Bosna, Morava, and Vardar.

Geographers have long urged the revision of administrative units with reference to geographical and economic factors, but such reforms come slowly. In the case of the Kingdom of the Serbs, Croats, and Slovenes we must admit that religion and party politics have still proved the decisive factors in the new subdivisions of the country.

THE REGION OF MOUNT LOGAN, GASPÉ PENINSULA

By J. Franklin Collins and Merritt L. Fernald

The Gaspé Peninsula, as recently pointed out in this journal,[1] was one of the first known parts of Canada, claimed for France by Cartier in 1534. "But though the oldest it is far from being the best known section of the country." To be sure, Dr. J. M. Clarke, under the title "The Heart of Gaspé," has made known the region of Percé, one of the finger tips of the region; but the sketch "Across Gaspé" is the first general account available of the backbone of Gaspé, the Shickshock Mountains.

In 1844 Sir William E. Logan, accompanied by a young assistant who later became the distinguished geologist, Alexander Murray, crossed the central-western section of the peninsula from Cap Chat (or Chatte) to the Baie des Chaleurs. About seventeen miles up the Cap Chat River he entered the Shickshock Range and in his narrative of the trip mentioned some of the mountains adjacent to the river.

> Both the principal summits we visited. In ascending the eastward one, which stands exactly opposite to the lower part of the valley of the Chat, and seems to terminate it, looking from the St. Lawrence, we clambered up the north side of the range, which presents a face whose slope cannot be much under 45° for 3000 feet; and we found that before the horizon was clear over the lower ridges between us and the great river, we had attained the elevation of 1753 feet above its surface. The highest spring of water we could discover, which was an abundant one of excellent drinkable quality, coming from the strata at the upper base of the peak, was 3544 feet up. The summit peak itself, a bare pointed rock, was 3768 feet, while the broad flat top of another mountain summit, two miles to the westward, which went among us by the name of Mattawees (the Micmac word for a porcupine)—from our having killed one of these animals as we scaled its side,—and on which we rested the first night of our ascent, having reached it by mistake, was 3365 feet. A deep ravine separated Mount Mattawees from the main peak, and another one severed it from a dome-shaped top nearly its own height, about a mile and a half to the westward, between which and the gorge of the Chat stood another gigantic boss.
>
> The main summit to the westward of the Chatte, to which we gave the name of Bayfield Mountain, in honour of Captain Bayfield, who on one of his Charts has indicated its position, we ascertained to be 3471 feet, after having reached it by a very steep and fatiguing ascent from the gorge to a precipitous mountain knob, 2669 feet high,—which acquired the title of the Old Man [Bonnehomme], from the existence of an erect stone in a step at its edge, in the position of one watching what might be passing below.[2]

Ever since Logan's report in 1846 the name Mt. Logan has had a regular place on maps of Canada or of the Province of Quebec, and slightly to the west has appeared the name Mt. Bayfield. In the interval up to 1918, however, no definite attempt to identify with exactness the mountains described by Logan seems to have been made. During that summer the Canadian

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[1] F. J. Alcock: Across Gaspé, *Geogr. Rev.*, Vol. 14, 1924, pp. 197–214.

[2] Sir William E. Logan: Geological Survey of Canada: Report of Progress for the Year 1844, Montreal, 1846, p. 11.

geologist, Professor A. P. Coleman, ascended the Cap Chat River and undertook an exploration of its mountains, "but owing to bad weather and the lack of knowledge of the mountains by the writer's guides, less was accomplished than was hoped for.

"It was intended to climb mount Logan, shown on the geological map as having a height of 3,768 feet, and about 17 miles up the river. The guides had not heard of the mountain and maintained that mount Nicolabert

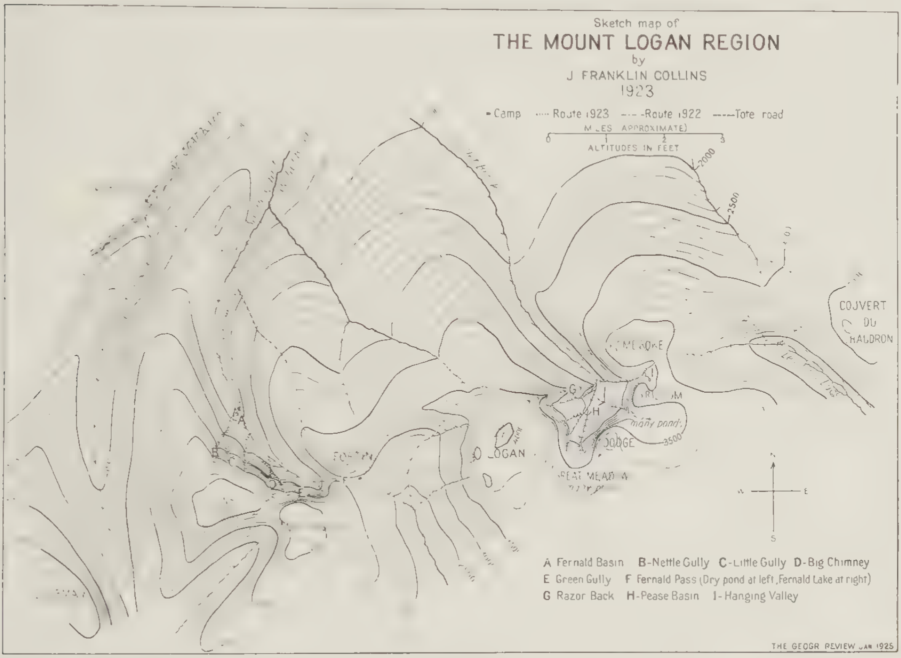

FIG. 1—Sketch map of the Mt. Logan Region.

[Logan's Bonnehomme], farther up the river, was the highest peak, so it was agreed the expedition should go to that point."[3]

Coleman and his party were handicapped by fog and rain and, after attempts to reach Mt. Logan by ascending a high ridge (3086 feet) opposite the mouth of Pineau River, were forced by bad weather and depletion of food supply to turn back without seeing that mountain.

In July, 1922, Professor Arthur Stanley Pease and the junior writer, finding themselves on the Gaspé coast with a few days at their disposal, attempted to rediscover the somewhat mysterious Mt. Logan. One of our guides of sixteen and seventeen years before on Mt. Albert and Tabletop Mountain at the eastern end of the Shickshock Range, Joseph Fortin of Ste. Anne des Monts, was fortunately open for an engagement but owing

[3] A. P. Coleman: Physiography and Glacial Geology of Gaspe Peninsula, Quebec, *Canada Geol. Survey Bull. No. 34*, 1922, p. 27.

FIG. 2—Logan Range from above Locked Camp. Mt. Logan at left; Mt. Fortin, back of spruce; Fernald Pass, in center; Mt. Mattaouisse, capped by fog; Mt. Collins, at right.

to an injury to a shoulder was unable to pole a canoe; and he disclaimed any knowledge of Mt. Logan. So the party started upon an equality as regards familiarity with the region, following with a horse and cart a recently cut logging road up the Cap Chat as far as Pineau River which enters it from the west. The central part of the Shickshock Range was clearly visible from various points along the road, and standing in the middle of the background as we left the St. Lawrence was one great dome with a sharp peak higher than the rest, thus coinciding with Logan's account of his mountain, "exactly opposite to the lower part of the valley of Chat, and seems to terminate it, looking from the St. Lawrence." But to the settlers and the guides of the salmon fishers along the lower eight miles of the river the mountains were wholly undifferentiated. Asked what they called a special mountain, then another and still another, they gave the unvarying answer: "Oh, that is the Shickshock Mountain;" or occasionally they would apply the name Couvert du Chaudron somewhat indiscriminately to any bare-topped dome.

It proved a fortunate circumstance that the party was forced to follow the tote road rather than the channel of the river, for about seventeen miles from the mouth of the river, in the region of the "Locked Camp," the road passes over high ridges and bluffs, bringing clearly into view to the south and east the northern steep wall of the Shickshock Range. It was evident that Logan's country was in sight, but falling into the same error as Coleman the party, passing the proper spot from which to strike off toward Mt. Logan, plodded on to the mouth of Pineau River. Here the steep mass which Coleman had ascended, and to which the name "Mt. Coleman" is here applied, rises across the river to the northeast. From the mouth of Pineau

FIG. 3—Forms a panorama with Figure 5 which it continues westward. Mt. Collins, at left; Mt. Coleman at right.

River Logan's "Bonnehomme" came into view, a beautiful slope rising abruptly from the river and known to the local guides always as "Nicolabert." A hunter's trail was followed to the base of Nicolabert and opposite it to the somewhat lower Le Frère de Nicolabert; but, as the southern outliers of the range were in sight, it was evident that a return must be made to the Locked Camp if Mt. Logan was to be reached. Proceeding eastward from above the Locked Camp in the afternoon of July 21 the party reached the base of the 3000-foot northern wall of a mountain before dark. After a struggle through spruce pucker brush and over a precipice of some hundreds of feet, camp was made at the northwestern outlet of a cirque basin. The basin measured about three miles long, east and west, and one mile broad. Pease named it "Fernald Basin." To the south rose the steep and often quite precipitous northern wall of the dome mentioned by Logan as being half a league west of Mattaouisse: to the east it merged into the abrupt wall of Mattaouisse, which at the head of the basin dropped to a graceful saddle (Fernald Pass). North of the Pass and the Basin rose another steep-walled and nameless mountain.

With only one day available for the alpine crests the mountain to the north, named Mt. Fortin, was selected. After reaching the crest, botanizing all the way, the party descended into Fernald Pass, arriving there in the early afternoon. In every chimney and cranny were discovered arctic-alpine plants heretofore unknown south of Cape Chidley or east of the Rockies. It had been supposed that Mt. Mattaouisse was Mt. Logan; but the sudden appearance farther east of a higher mass confused the situation, and before the puzzle could be solved two electrical storms with hail and sheets of rain accompanied by violent wind broke over the Pass—one from the north, the

other from the south—and abruptly ended the exploration for 1922. Coleman's account of his chagrin at getting so near Mt. Logan but finally being thwarted by storm and fog was well appreciated.

Stimulated by the rich botanical discoveries of the tantalizingly brief and geographically inconclusive experience of 1922, a larger botanical enterprise was arranged for the summer of 1923. The party of seven botanists, Carroll W. Dodge of Harvard University, Ludlow Griscom of the American

FIG. 4—Mt. Logan from Mt. Pembroke.

Museum of Natural History, Kenneth Mackenzie of the New York Botanical Garden, Arthur Stanley Pease of the University of Illinois, Lyman B. Smith, a student in Harvard College, and the two writers, left Cap Chat for the Locked Camp on July 6, 1923, accompanied by Joseph Fortin, Israel Thibeault, and Léon Dugas. On the 7th a temporary camp was established below the outlet of Fernald Basin and opposite a steep ravine to the south designated Nettle Gully. The walls of Nettle Gully were too precipitous and slippery for ascent, but about the cold base at an altitude of scarcely 400 meters (1300 feet) were found plants heretofore known only from the summit of Mt. Albert and later in the season a fern which had been known only along the Coast Ranges from Alaska to California.

Reconnoitering expeditions, at first from the lower camp and later from a camp in Fernald Pass, showed that the real Mt. Logan is the summit with the "bare pointed rock," the highest of this immediate group, slightly over 4100 feet, and lying two or three miles east of the head of Fer-

FIG. 5

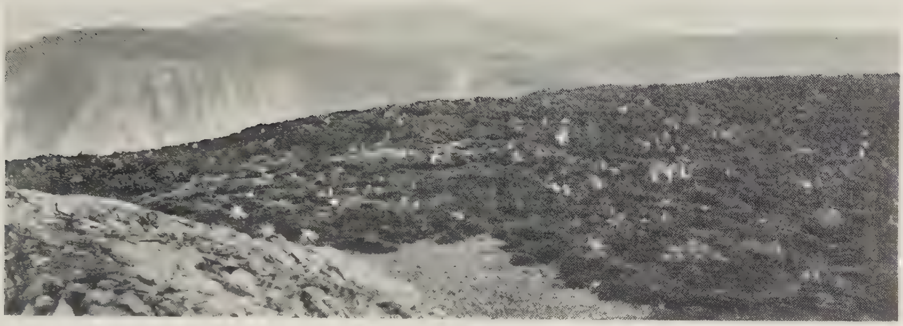

FIG. 6

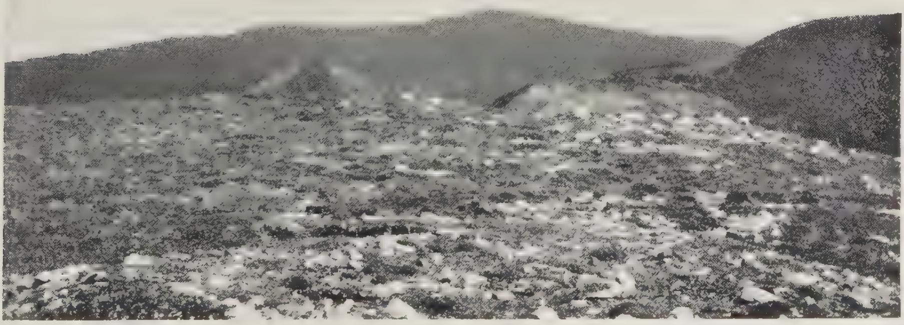

FIG. 7

FIG. 5—Logan Range from the lower Cap Chat River. Mt. Logan (highest point, in middle) merging into Mt. Fortin; Fernald Pass (notch); Mt. Mattaouisse and Mt. Collins (mostly hidden at right).

FIG. 6—Looking slightly north of east from crest of Mt. Logan. In foreground portion of scrub-covered tableland of Logan; beyond it at left Pease Basin with Mt. Pembroke beyond; Couvert du Chaudron in middle background.

FIG. 7—Mt. Logan with its distinctive rock crest from summit of Mt. Collins.

nald Pass. "The broad flat top," described by Logan as Mt. Mattaouisse and separated from Mt. Logan by "a deep ravine," is the mass rising to the south of the Pass; and, just as Logan described it, another ravine, The Saddle, "severed it [Mattaouisse] from a dome-shaped top nearly its own height [Mt. Collins, as designated by members of our party] about a mile and a half to the westward, between which and the gorge of the Chat stood another gigantic boss [Mt. Coleman]."

A party led by Pease made a preliminary ascent of Mt. Logan, discovering that its northern and eastern walls plunged abruptly into a basin far more rugged and picturesque than Fernald Basin. Further explorations by all members of the party, continued over several days of bleak and stormy weather by Dodge, Griscom, Pease, and the senior writer accompanied by Joseph Fortin, showed that the great gulf which separates Mt. Logan from the next dome to the northeast, Mt. Pembroke of some of the older maps, was indeed more ragged than Fernald Basin. It was also the home of many more localized arctic, cordilleran, and endemic plants; and in recognition of Pease's activity in exploring its cliffs and talus and of his well-known energy in exploration of the White Mountains this steep-walled gulf is here called "Pease Basin." To the south and east of the basin extend many square miles of meadows (Great Meadows) with numerous small ponds; and, capping the southeastern crest of the basin are twin summits (Dodge and Griscom), separated by a brook which cascades for hundreds of feet down the abrupt wall. Between Griscom and the main mass of Pembroke is a steep talus of angular gravel, Hanging Valley, with a brook descending its slope; but lower down both the brook and the talus give way to a dense scrub forest, and opposite Hanging Valley, slightly south of west, is a distinct and narrow white ridge of mica schist, Razor Back.

Some of the party located and tested Logan's "highest spring of water . . . coming from the strata at the upper base of the peak," thus confirming our idea that we were actually following Logan's tracks; and Dodge and Joseph Fortin penetrated the fog, which repeatedly interrupted exploration, far enough to see Les Trois Lacs which lie to the east under the dome most generally known in the region as Couvert du Chaudron. The latter name has been variously applied in the past, but the dome indicated on our map is the one visible from Ste. Anne des Monts.[4] Captain Samuel Coté, the most experienced woodsman of the region, gave us an explicit account of its position with Les Trois Lacs at its southwestern base; and our own guide, Thibeault, was familiar with it through trapping in the basin of the Little Cap Chat which separates Couvert du Chaudron from Pembroke. In fact, Thibeault assured us that the basin which forms the north-fâcing gulf between Pembroke and Couvert du Chaudron is much grander than Pease Basin. Late in August two members of the party, Smith and Fernald, accompanied by Joseph Fortin and Israel Thibeault, reëstablished camp in

[4] From the village of Ste. Anne des Monts, Mt. Logan cannot be seen; but its characteristic summit, well to the west of Couvert du Chaudron, is visible from the end of the wharf.

Fernald Pass, planning to reach Couvert du Chaudron and the basin of the Little Cap Chat; but unceasing gales, fog, a two-days' blizzard, and more fog cut off all field work, and they were forced to give up the quest and to return to the Locked Camp.

Thus we feel that at least a small portion of the Shickshock Mountains that has long been an obscure region is better understood. But there is much exploration yet to do. A fascinating program for a few weeks of clear autumn weather would be to follow the range eastward to Mt. Albert or westward to Mt. Bayfield. Mt. Bayfield, although quite unknown to the guides and woodsmen of the region, is certainly in the general position indicated for it by Logan and by Coleman and, as seen from the peak of Mt. Logan, seemed quite as high if not even higher than the latter mountain. The most feasible route has not been worked out, but with the interest in the Shickshock Mountains that is now developing Mt. Bayfield will soon become better known. Our route to Mt. Logan through Fernald Basin involves a hard pack up the nearly precipitous wall below the Pass, and it is probable that a more gradual trail could be worked out along the branch of Ouillet Brook between the westerly flanks of Fortin and Logan. The hunters' route up the Little Cap Chat between Couvert du Chaudron and Pembroke, thence to the broad meadows east of Pease Basin, is said to be quite feasible: it starts nearer civilization, and equipment can be hauled nearer to the mountains; but our route from above the Locked Camp has the advantage of a recently beaten trail and of cleared camp sites at convenient distances along it.

THE GREAT DESERT

AN APPRECIATION OF E. F. GAUTIER'S "LE SAHARA"*

By G. M. Wrigley

Prefatory: The Problem of the Desert

The Desert has been "conquered." Witness the Great American Desert of the forty-niners, "hunger and thirst and an awful silence," as a survivor described the crossing that named Death Valley. Then was the passage perilous by northern or southern routes. "The desert through which we are passing is strewn with dead cattle, mules, and horses. I counted in a distance of fifteen miles 350 dead horses, 280 oxen, and 120 mules; and hundreds of others are left behind unable to keep up"—thus a pioneer on the route west of Humboldt Sink. "Broken wagons, dead, shrivelled-up cattle, horses and mules as well, lay baking in the sun, around the dried up wells that had been opened, in the hopes of getting water. Not a blade of grass or green thing of any kind relieved the monotony of the parched, ash-colored earth, and the most melancholy scene presented itself that I had seen since I left the Rio Grande"—thus John W. Audubon on the Colorado desert route.[1] Today the railroad and the automobile have entirely transformed travel in the arid West. The increased use of the latter means of transportation in particular has led to the taming of the wilderness. Individuals and the states have contributed to this end, and the United States Geological Survey has well in hand a systematic program for making the desert safe and accessible by mapping, marking, and improving its watering places. The federal work was begun in 1917 with a survey in that and the succeeding year of "the driest, hottest, and least explored part of the desert region, comprising 60,000 square miles in southeastern California and southwestern Arizona." Signs directing travelers to water were erected at 167 localities in the former state and at 138 in the latter. Danger is now largely a matter of negligence.[2]

Similar conquests are in progress in the Old World. From time immemorial travel between Syria and Mesopotamia sought the circuitous route by the "fertile crescent" in preference to the direct roads across the desert, used chiefly by caravans carrying luxury articles. Referring to the waterless stretch of fifty miles on the way to Palmyra, Huntington observes that while "previous to the opening of the railroad from Damascus to Aleppo caravans containing an annual total of from a thousand to fifteen

* E. F. Gautier: Le Sahara. Maps, bibliogrs. (Collection Payot.) Paris, 1923.

[1] Quoted by R. G. Cleland: A History of California: The American Period, New York, 1922, pp. 238–239.

[2] Preface by O. E. Meinzer to "Routes to Desert Watering Places," etc., *U. S. Geol. Survey Water-Supply Papers*, 490-A, -B, -C, -D, 1920–1922.

hundred animals occasionally passed this way, many more chose to go a hundred and fifty miles farther north by way of the well-watered route through Aleppo."[3] Today a regular automobile service operates between Damascus and Babylon, following the military road built by the Palmyrene queen. Under the heading "Increased Traffic Across the Syrian Desert" the *French Colonial Digest* for September, 1924, reports:

"In 1923 the United States exported to Palestine and Syria 780 passenger cars and 18 trucks.

"From figures for March and April, showing the increase in motor transportation across the Syrian Desert between Beirut and Bagdad, it is believed that further development of this means of communication will materially assist the growth of commerce in Syria. The transport company, which maintains service between the two points mentioned, recently covered the 614 miles between Bagdad and Beirut in 16½ hours, an average speed of 37.2 miles per hour."

And in the same paper is news of the extension of the service to Teheran.

Mechanical transport is in general use in the dry interior of Australia; the continent has been recently crossed from east to west by motor car.[4] In a recent number of the *Geographical Review* Frederick K. Morris has described the great facilitation of exploration in desert Mongolia by use of motor transport.[5]

But the greatest triumph over the desert is in the recent crossings of the Sahara which M. Gautier has described in a preceding article. For centuries the great African desert veiled a mysterious continent from European eyes. Prior to the French conquest of Timbuktu in 1894 only four Europeans had seen that city of legendary fame. Following the bold ventures of the Citroën and Gradis expeditions comes the advertisement of a projected tourist trip across the desert to Timbuktu. Motor excursions are run on regular schedule in the northern desert. Almost must one agree with Buchan that romance has departed from travel.[6]

Undeniably the desert has been conquered as a barrier, a triumph won over space: but in the very means of conquest a negative sort of triumph is implied. How extensive are these desert lands that we congratulate ourselves upon crossing as rapidly as possible?

The desert has been defined in varying terms, and estimates of its area vary accordingly.[7] As regards the usage of the term "arid," however, there is general agreement—the arid regions are those where rainfall is insufficient

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[3] Ellsworth Huntington: Palestine and Its Transformation, Boston and New York, 1911, p. 346.

See also E. C. Semple: The Ancient Piedmont Route of Northern Mesopotamia, *Geogr. Rev.*, Vol. 8, 1919, pp. 153–170. On an important route through the desert see Douglas Carruthers: The Great Desert Caravan Route, Aleppo to Basra, *Geogr. Journ.*, Vol. 52, 1918, pp. 157–184.

[4] Michael Terry: From East to West Across Northern Australia, *Geogr. Journ.*, Vol. 64, 1924, pp. 21–43.

[5] F. K. Morris: Notes on the Mapping Program of the Third Asiatic Expedition in Mongolia, *Geogr. Rev.*, Vol. 14, 1924, pp. 287–292.

[6] John Buchan: The Last Secrets: The Final Mysteries of Exploration, London, Edinburgh, and New York, 1923. Reviewed in this number of the *Geogr. Rev.*

[7] See Erich Kaiser: Was ist eine Wüste, *Mitt. Geogr. Gesell. in München*, Vol. 16, 1923, pp. 1–20. Abstracted in this number of the *Geogr. Rev.*

for successful agriculture without irrigation. The arid lands include the deserts and certain marginal areas of peculiar interest and importance to the expanding population of today.[8] Wagner's recent estimate based on Köppen's classification of climate gives the area occupied by the arid lands as 26 per cent of the total land surface. Of this, 18,000,000 square kilometers, or 12 per cent, is described as desert.[9] In his classic paper on the lands of the arid region of the United States Major Powell included more than four-tenths of the entire country excluding Alaska. Jefferson[10] classes one-third of the country as arid, describing three degrees of aridity—semi-arid (720,000 square miles), arid (250,000 square miles), and desertic (35,000 square miles). O. E. Meinzer gives 500,000 square miles as the area of "desert" in the United States, that is, one sixth of the country.

The Redemption of the Desert

Whatever figures we accept, even if we exclude the broad belts marginal to the humid lands, we find a substantial portion of the earth too deficient in water to support a significant population. This is an important fact confronting the students of the population problem who seek its solution in development of the waste lands of the world. The sustenance space of the earth has been enlarged in the past and is unquestionably susceptible of further enlargement. In the immediate past it has been enlarged notably in far northern lands. A striking example is to be found in Alaska. The present and potential value of that "arctic waste" of sixty years ago is described by Mr. A. H. Brooks in this number of the *Geographical Review*. Optimistic views on the future of the desert belts of the world have been based on analogy with recent progress in the northern lands. The problem, however, is dissimilar. As Mr. Stefansson has pointed out, the northern lands were formerly discredited in large measure out of unfamiliarity—they presented the terrors of the unknown. On the other hand the early centers of civilization—and this is true of the new world as of the old—were in the desert belt of the earth. Man attained his early civilization in struggle with the desert. The idea of growing food crops in Alaska is new. The idea of making the desert productive is old. Always has man been obsessed with the desire to conquer the desert: always has he had before his eyes the vision of making the desert blossom as the rose. An ancient slogan this and fresh today as in the times of Isaiah. What has it accomplished in the desert lands? How far has man replaced the thorn and the briar? Speeding through the desert on steam or gasoline is one thing: living on the desert is quite another.

[8] The American Geographical Society is making a special study of marginal or pioneer belts of various types.

[9] Hermann Wagner: Die Flächenausdehung der Köppenschen Klimagebiete der Erde (1918), *Petermanns Mitt.*, Vol. 67, 1921, pp. 216–217. For a map of Köppen's climatic regions see R. De C. Ward: A New Classification of Climates, *Geogr. Rev.*, Vol. 8, 1919, pp. 188–191 (map opp. p. 188). The desert regions are determined by rainfall in relation to temperature, ranging down from 32 cm. (20") at a temperature exceeding 25° C., the steppe lands from 64 cm. (40") at a temperature exceeding 25° C.

[10] Mark Jefferson: Aridity and Rainfall Maps of the United States, *Geogr. Rev.*, Vol. 1, 1916, pp. 203–208.

In the great desert belt of the Old World are extensive ruins of ancient civilizations buried under the desert sands. Elsewhere ancient systems of irrigation have been maintained. In India modern irrigation with the aid of transportation has done much to relieve the scourge of famine. Mesopotamia is awaiting a restoration of prosperity such as modern engineering has given to Egypt. The best criterion of progress in conquest of the desert, however, is to be looked for in the arid belts in North America and the southern hemisphere—in lands where European civilization and resources have enjoyed freest scope for conquest.

First be it remarked that conquest of aridity, broadly speaking, means irrigation; that irrigation is a coöperative rather than an individual matter; and that large-scale undertakings are essentially public matters. In Mexico, Chile, Peru, and Bolivia, with large Indian populations, irrigation is still practiced for the most part on the small scale of ancient times. In Argentina water conservation is being apprehended as a national problem, associated in the main with expansion into the broad arid stretches of the southern territories. In 1911 Professor Bailey Willis was called upon by the Argentine government to conduct an investigation of resources, primarily of water, in northern Patagonia. In his report he points out the need for a comprehensive survey that gives the problem national scope. To make fruitful the barren lands taxes the skill and resources of the country to the utmost. "I need but cite the experience of the Reclamation Service of the United States of North America which was that only one in ten of the projects for storage and utilization of waters for irrigation in the United States gave such promise of a reasonable return upon the cost of construction under Government supervision that it could be undertaken on the condition that it should eventually pay for itself. The works carried out by that service are more important to the people of the United States and they involve engineering questions as difficult as those of the Panama Canal."[11]

In Canada in 1920 something over 1,000,000 acres of land was under irrigation in the prairie provinces, the major part included in the Lethbridge and Bow River projects of the Canadian Pacific Railway. There is little prospect of further development without government aid. The problem, however, is relatively unimportant here compared with that in the United States, South Africa, and Australia. It is in these countries that irrigation has accomplished its most striking results. Take for instance the Mildura project, a remarkably successful private undertaking in northwestern Victoria. At Mildura land, which in 1886 maintained only 1300 sheep and realized a revenue of £7-10-0, produced £1,500,000 of primary products in 1920 and supported a population of 20,000.[12] It is such a blossoming of the desert that breeds the optimist, that creates the mirage of the "million settlers of tomorrow." Unfortunately, more than optimism is required for a Mildura.

[11] Bailey Willis (for the Ministry of Public Works, Argentina): Northern Patagonia, New York, 1914, p. 12.

[12] S. H. Roberts: History of Australian Land Settlement (1788–1920), Melbourne, 1924, p. 347.

Nearly half a century has elapsed since the "Father of United States Reclamation" envisaged the problem of opening up the arid West. It may be noted that, with all his keen appreciation of the blessings of irrigation, he clearly laid down the fact that "the amount of irrigable land is but a small percentage of the whole area."[13] In 1919 the total area of irrigated land in the United States was 19,000,000 acres, about 30,000 square miles—achieved at a price, as we have already indicated in the quotation from Bailey Willis. On the 24 national irrigation projects there were in 1921 but 32,964 farms, with a population of 125,883. A few years ago an American geographer, writing in the *Geographical Journal*, asked the question "Has irrigation in the United States been a success?" and answered, "Neither Yes nor No. It has been an unquestionable success in many of the 55,000 separate enterprises. It has been a reasonable success in a still larger number, and it has also been a financial failure in many. No reliable figures are available for no record has been made of the cases of failure."[14] Official opinion on the reclamation of the American desert remains conservative. "Inspired by the successful agricultural development of certain portions of the arid regions of North America by irrigation in recent years, some writers have painted colorful word pictures of those regions in the future, when man has transformed them all into productive farms. Undoubtedly there are thousands of acres that can still be developed by irrigation, and the acreage will perhaps be increased still more by changes in economic conditions that will permit a greater cost of production, or by improved methods that will increase the duty of water. Nevertheless it is true that the quantity of water available from all sources is not sufficient to irrigate more than a small part of the aggregate area of arid land."[15]

In South Africa the problem of aridity assumes a broad aspect because it involves so much of the country. In 1920 the Government appointed a Drought Investigation Commission, the interim report of which was published in 1922. The Commission is largely concerned with the conservation of the grassland cover, for the bulk of the land in South Africa must remain pastoral. The water available for irrigation is limited. "Mr. Kanthack, late Director of Irrigation for the Union, has made an estimate, based as far as possible on actual gaugings, of the run-off from all individual catchments in the country. From his run-off estimate, taking all factors into consideration he estimates liberally that the total irrigable area actual and potential, is only one per cent . . . even his sharpest critic cannot deny that Mr. Kanthack's figure in any case represents the order of magnitude, so to speak, of the ultimate economically irrigable area. The dreams of enthusiastic laymen of seeing South Africa one great irrigated garden are, therefore, incapable of fulfilment."[16]

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[13] J. W. Powell: Report on the Lands of the Arid Region of the United States, Washington, D. C., 1879; reference on p. 23.

[14] R. H. Whitbeck: Irrigation in the United States, *Geogr. Journ.*, Vol. 54, 1919, pp. 221–231; ref. on p. 230.

[15] D. G. Thomson: Routes to Desert Watering Places in the Mohave Desert Region, California, *U. S. Geol. Survey Water-Supply Paper* 490–B, 1921, p. 101.

[16] R. J. van Reenen: A Résumé of the Drought Problem in the Union of South Africa, *South African Journ. of Sci.*, Vol. 20, 1923, pp. 178–192; reference on p. 187. See also Mr. Kanthack's paper "Irrigation in South Africa," *South African Geogr. Journ.*, Vol. 5, 1922, pp. 13–24; noted in *Geogr. Rev.*, Vol. 13, 1923, p. 308.

In Australia the question of the arid terrain has assumed a political aspect that tends to obscure the intrinsic nature of the problem. However, a competent observer estimates that Australia contains over 2,000,000 square miles that cannot be developed to any extent without extra water. The area brought under cultivation by irrigation is a very small part of this total, about 6 in 10,000.[17] The possibilities of extension are likewise limited. One may recall the words of caution with which M. Privat-Deschanel concluded his admirable paper, "La question de l'eau dans le bassin du Murray."[18] "But the principal difficulty encountered in irrigation is a general geographical phenomenon, the prejudicial effect of which it is impossible to change; it is the extreme irregularity of the rains. . . . We would not throw discredit on the agricultural and pastoral value of irrigation, a value which is unquestionable. But it is well to guard against exaggeration in this connection and to recall certain illusions regarding the French Sahara where artesian wells have certainly brought about an amelioration but which have not changed the essentially desertic character. Man strives in vain against the geographical forces; they always carry the day."

We shall conclude this section with a quotation from Brunhes' well-known work on irrigation: "There are some naturally arid regions where man has introduced cultivation, thanks to irrigation. Man thus modifies the natural conditions which are imposed on him. But this he can only do in regions where there is water under one form or another in sufficient quantity to permit him to organize irrigation. He cannot create water; he uses the water which he discovers or collects. He cannot therefore irrigate wherever he would; there are arid regions condemned to an irremedial aridity. We have said, and we repeat it, that irrigation enterprises are possible only under certain natural conditions."[19]

Le Sahara

So much by way of preface—a lengthy prelude to the review of a book of 174 small pages. Its purport is to emphasize the reality, magnitude, and complexity of the problem of the arid lands that our successful "conquests" tend to ignore or belittle. Professor Gautier's contribution is notable alike for its learning and its spirit. "Le Sahara" is a volume in one of those admirable French series that afford not only authoritative material for the general reader of cultivated mind but also an excellent introduction to the subject for the serious student and a *précis* for the specialist. For this particular region it is the more welcome because the only work dealing thus comprehensively with the Sahara is Schirmer's excellent book which, however, was published in 1897 and is now out of print and difficult to obtain.

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[17] Griffith Taylor: Geography and Australian National Problems, *Rept. Australasian Assoc. for the Advancement of Sci.*, Vol. 16, 1923, pp. 433–487.

[18] *Ann. de Geogr.*, Vol. 17, 1908, pp. 145–160, 224–237, and 302–318.

[19] Jean Brunhes: L'Irrigation: Ses conditions géographiques, ses modes et son organisation dans la péninsule ibérique et dans l'Afrique du nord, Paris, 1902, p. 432.

The Sahara is the greatest of the world's deserts and that which, barring the desert of the United States, is best known or, as might be more truly said, is least unknown. Out of a long familiarity, modestly and with respect for his subject, Gautier summarizes what is known of it. At the same time he creates of the great desert a living picture, if indeed we may apply such a term to a region "distinguished by its relatively azoic character."

M. Gautier does not attempt to define the desert beyond the simple statement that it is a region where the rainfall is insufficient: where there is lack of equilibrium between the quantity of water that falls from the sky and the loss by evaporation. From the human point of view the important feature of the desert is its resources of water. M. Gautier's discussion may be considered as centering primarily around the two categories into which these resources fall, the superficial and the deep-seated waters.

The Superficial Waters

The superficial waters of the Sahara are derived in part from the highland regions without but mainly from the rains that fall on the desert itself. In correction of a common misconception it is emphasized that there is no corner of the planet where rain *never* falls. The Sahara, like all other deserts, has its rains, though it is difficult to determine their amount and frequency. At the meteorological stations in the French Sahara the annual rainfall oscillates about 100 millimeters or rather less. The striking feature is the irregularity. At Tamanr'asset in 1910 the rain gauge registered nothing. "On January 15, 1922, a storm followed by a torrential rain swept over the region. The roofs of the houses almost all fell in, and the native population took refuge in the *borj* and the fort. The waters carried away houses and gardens bordering the wadi. On the 16th the rain continued to fall, the wadi overflowed, the water racing past with the speed of a galloping horse . . . the outer wall of the fort collapsed burying 22 persons; under an icy rain the victims were taken out, 8 dead and 8 wounded. On the 17th the rain fell less heavily, the wadi subsided and the weather cleared; snow was seen on the neighboring summits."[20] Tamanr'asset is in the heart of the French Sahara, in the Ahaggar, at an altitude of 1400 meters. There is not an oasis of the desert that does not preserve a similar record of the last great rain and the damage it occasioned.

The rare desert rains have an importance out of all proportion to their frequency. The nature of the work they accomplish and their utility are dependent upon the terrain upon which they fall. The fundamental phenomenon of the Sahara is the dryness of the air. At Tamanr'asset, for instance, the relative humidity ranges between 4 per cent and 21 per cent. Daytime temperatures are high; in the sand of the dunes temperatures as high as 70° C. have been observed. A vegetative covering is lacking. Where the rains fall on a surface without organized drainage lines and especially

[20] Le Sahara, p. 18.

on impermeable rock or surfaces covered with the desert "patina," the intense evaporation rapidly removes the water. Where drainage channels exist the water is concentrated and conserved. In the western Sahara the vegetation is largely confined to the wadis, the terms "wadi" and "pasture" are interchangeable. The topography of the desert is all important. Now it is a topography reached by an evolution very different from that of the lands of normal precipitation. The desert model is characterized by closed basins. Usually a predominant rôle in the production of the basins is assigned to deflation. This is not surprising, but Gautier believes it to be exaggerated.

"In the desert the wind is almost the only element of life and movement in the domain of death and immobility. A journey in the desert is a continuous strife against the wind charged with sand and, in moments of crisis, a painful physical struggle. In the details of the relief the eye at each instant sees the evidences of eolian erosion. The first impression of the traveler is that he has penetrated into a domain where the wind reigns without rival. When the Suez canal was projected opponents of the scheme objected that the desert wind carrying torrents of sand would choke the canal. Actually the canal company devoted only an insignificant part of its annual budget to the work of dredging. Here is in fact an instance of the impossibility of our imagination's measuring the real effects of the wind."[21]

Orogenic movements constantly tend towards the creation of basins which in regions of normal drainage are broken down: in the desert fluvial erosion acts negatively by its insufficiency. On the other hand the wadis tend to fill up the basins by the deposition of alluvium. Thus are formed the great gravelly stretches, "flat as the sea," known as *serir* in the eastern Sahara, *reg* in the west. Rosita Forbes has described the *serir* crossed on her journey to Kufara an "amazing brown flatness, utterly unchanging—an endless, monotonous expanse of hard sand mixed with very fine gravel."[22]

Whatever its importance compared with fluvial erosion the work of the wind is nevertheless great. Reference has already been made to its sculpturing effect in detail; on a large scale it is seen in the production of *hamada*, bare, polished rock surfaces. The most striking effect of the wind, however, is the dunes. In the Sahara the masses of dunes, often covering immense areas, are known as *ergs*. The two great ergs of the Algerian Sahara, the eastern and western, measure approximately 300 by 150 kilometers. The Libyan erg is as big as France. Fluvial erosion plays no direct part in dune formation, but its indirect action is of the greatest importance, for only thus can be explained the derivation of a considerable part of the material. Corrasion encounters a serious obstacle in the desert patina that covers the bare rock surfaces with a resistant epidermis.

[21] *Ibid.*, p. 29.

[22] Rosita Forbes: Across the Libyan Desert to Kufara, *Geogr. Journ.*, Vol. 58, 1921, pp. 81–101 and 161–178; reference on p. 93.

The *barkhan*, the crescent-shaped dune, is not characteristic of the Sahara. The confused masses of the erg can be classified into certain well recognized forms, and these exhibit a close relation to the underlying topography. They constitute relatively fixed elements known to the guides. The French officers of the meharists of Algeria say they have not changed in the half-century. Measured in longer terms of time they move of course in the direction of the dominant wind. Where the dunes overlie a well developed system of wadis the erg has resources of water and pasture. This is the case with the great eastern and western ergs of the Algerian Sahara and is evidently connected with the networks of the Saura and Igharghar systems respectively. Thus the wadis keep their usefulness even when dead and buried. On the former of these the long lines of pasture are indeed known to the natives as wadis, an unconscious but undoubtedly correct recognition of the valleys hidden under the dunes. On the right bank of the Saura are two distinct little ergs, the one known as the erg of thirst, the other as the humid erg. The one, encircled by rocky crests, is restricted to its own source of moisture, the other lies in a valley deriving water from afar.

As the arid cycle in a dune region progresses the wind destroys the old fluvial system, effacing the channels or burying them under so deep a layer that the subterranean water cannot be utilized by plants or man. Such is the case with the Libyan erg, some 1200 kilometers long and 400 or 500 broad, a region as unknown as the south pole. The other parts of the Libyan desert also exhibit conditions of extreme aridity. The reason, M. Gautier believes, lies not in any climatic circumstance but in the great antiquity of this eastern portion of the desert. It has had more time to dry. This brings us to the question of desiccation, a question of the utmost practical as well as theoretical interest.

The Question of Desiccation

The Sahara, like other planetary deserts, is the site of an ancient desert or series of deserts. Over great areas from Algeria to Egypt occurs sandstone of uniform facies but of various geological ages from Silurian upward. It is a desert formation of petrified ergs. This persistence of desert conditions is of course relative; there have been great oscillations. That of which we have the most apparent traces is the Quaternary. The Quaternary was a more humid period in the Sahara. The depth, the length, the multiplicity of the Quaternary channels attest this, as does the tropical fauna, a relict of which—the crocodile—still remains in the oases, while the Carthaginian elephant was extinguished by the Roman ivory hunters. But even so one must guard against attributing too great a rainfall to the region in this period. In the Quaternary the wadis terminated in closed basins. For the desert would be substituted steppe, affording an open road for tropical fauna to the Mediterranean. Even then, however, it is improbable that steppe extended all over the Sahara. Fossil wadis are lacking on the left

bank of the Nile. Reference has already been made to the *serir* of the Libyan desert; perhaps this represents a very old pre-Quaternary *reg*.

Coming to historical times, however, no such definite answer can be given to the question of climatic change. Few geographical questions have provoked more passionate argument. M. Gautier speaks of it with reserve. The historians and archeologists, he says, have not brought forward a single positive fact permitting the certain conclusion that the climate has changed in historical times in the Mediterranean countries. It is, however, quite another matter as regards desiccation of particular areas of the ground. It is incontestable that the absolute quantity of the superficial waters in the well-known parts of the Sahara is continually diminishing. The process of self-stimulated desiccation of the desert has been suggested above. River capture, too, has played a part in the process of desiccation—a rôle that has been emphasized by Schwartz, who makes it the basal fact in his well-known scheme for watering the Kalahari Desert.[23]

The most famous instance of capture is afforded by the Niger, the upper and lower portions of which were originally two distinct rivers. Formerly the upper portion extended much farther north, the river terminating in a shott, the salt layers of which include the famous deposit of Taudeni.

The Deeper Waters

As we have seen, the superficial waters of the Sahara bear a close relation to the points of water and pasturage, that is to the life of the nomads. Some of the oases also derive their water from superficial sources; but the majority are dependent on the deeper waters, the issuance of which is determined by faults or contact lines of geological formations. The origin of the deeper waters is also to be found in the desert rains. Gautier emphasizes the enormous quantities of water falling in the Saharan storms, rare as they are, and the vast extent of surface, the greater part of which probably consists of permeable rock. Passarge's hypothesis of fossil water he finds unworkable, though it has the merit of showing the bonds between past and present.

The Oases

The principal groups of oases are distinct individualities and must be described separately.[24] A discussion of the regions of the Sahara naturally resolves itself largely into a description of these groups. Egypt is unique, an oasis apart. Its most distinguishing feature, the dominance of the sedentary people over the nomads, has already been described by M. Gautier in the *Geographical Review*.[25] The Egyptian oases, Dakhla, Kharga,

[23] See the note, "The Redemption of the Kalahari," *Geogr. Rev.*, Vol. 11, 1921, pp. 623–626.

[24] This has been well expressed by Brunhes in his work on irrigation (cited in footnote 19) where he describes the desert as imposing on man a sort of "insular régime," an idea further developed in his "Géographie Humaine."

[25] Nomad and Sedentary Folks of Northern Africa, *Geogr. Rev.*, Vol. 11, 1921, pp. 3–15.

Baharia, Farafra, are the original type of oasis. They owe their existence to the local emergence of deep aquiferous layers; the waters are thermal. The number of inhabitants is insignificant; Dakhla has 17,000; Kharga, 8000; Baharia, 6000; Farafra, 632. Size is, however, no measure of importance; they lie on a route of strategic importance in ancient and modern times, the only route in the Libyan desert outside the Nile valley. On a continuation of this route lies the still little-known oasis of Siwa, the key to Egypt, and still farther along Jaghbub and Aujila.

To the south is the worst part of the desert, a dead angle, Tibbu Sahara. The Tibbus are the only black Saharans who have conserved their independence. In their citadel of the Tibesti are traces of the fauna of the more humid Quaternary; the Tibbus may themselves be considered as relict fauna. They are not true negroes; neither are they *métis*, for the type is fixed; are they the last of the Saharan Ethiopian? Tibbus are found in Borku also where, in the great basin termed by Tilho the Pays Bas of the Chad, waters are comparatively abundant and oases well developed. Here a new conquering element (Arab) has appeared in the last century.

The Kufara oases occupy an extraordinary situation, almost at the mathematical center of the Libyan desert, 400 to 500 kilometers in any direction to an inhabited region. It would be interesting to know the source of their abundant waters, sufficient to support some thousands of souls and flowing freely without man's intervention.

Between the massifs of Tibesti and Ahaggar south of the great bight in the north African coast line is the depression of Fezzan with an important group of oases, of which Murzuk is today the capital. Dunes are extensively developed, as is commonly the case over the low Quaternary valleys; the erg is humid and habitable. Water is present in the form of lakes, not temporary salt lakes (shotts) but lakes of permanent water, sometimes deep, generally brackish or saline, sometimes fresh. Barth and after him Duveyrier and Nachtigal estimated the population at 50,000. For abundance of water and number of palm trees the Fezzan may have rivals on the edge of the Sahara, but not for its situation in the heart of the desert: it is a unique case. The oases, however, are malarial, and the white race has not eliminated the black.

Of the oases of the western Sahara, Tuareg Sahara, as it may be denominated, those of Algeria are best known. The Algerian oases have in common the rarity of easily accessible water. In the Wad Saura where annual floods supply the superficial layers with water are wells with *shadufs*, and again on the Tunisian frontier are the curious oases of Suf. The water table in the Suf lies immediately below the surface sand. The gardens are planted in funnel-like holes excavated to the water level, and the work of the cultivator is not to furnish water but to remove the sand that tends to invade the hollows. But these are exceptional cases.

An eastern group of oases at the bottom of the basin at the foot of the Atlas derives its water from artesian wells. A western group aligned between

Figuig and In Salah forms a ribbon of verdure 1200 kilometers long, a "street of palms." It marks the boundary between the peneplain of old rocks and the Cretaceous and Tertiary plateaus. The natural seepage is augmented by subterranean galleries, *foggaras*. These have an immense development. For a single oasis, Tamentit for instance, they amount to 40 kilometers. The ground around the oases is veritably mined, and care must be taken by the traveler.

The Mzab oases have wells 60 meters deep, the water being drawn by animal power, but the expensive Mzab is dependent on commerce in the Algerian Tell.[26] For an oasis to be self-supporting it must have flowing wells or foggaras.[27]

With all their interest and importance the Saharan oases occupy a most insignificant part of the total area of the desert. Their waters issuing unexpectedly in the wilderness flow with a paradoxical abundance and nourish under the close-set palms gardens of dreams, the more marvelous by contrast with the immense dead spaces which must be crossed to reach them and the long days of hard, sometimes terrible, travel. Into the word oasis one inevitably comes to read something paradisiacal.

The Tanezrufts

At the opposite pole to the oases are the *tanezrufts*. M. Gautier proposes the generic use of this word, the name of an area in the Algerian Sahara. The tanezruft is a desert within a desert; an old desert that has had more time to desiccate; "on n'y séjourne pas, on y passe." In the greater part of the western Sahara the tanezrufts are annoyances to travel rather than obstacles. On the most frequented road between Algeria and the Niger bend between the wells of Ziza and Timissao are 180 kilometers without water and pasture. This seems frightful to European ideas but not to the Saharan. Farther west, however, it is true that direct communication between Lower Tuat and Timbuktu is almost impossible save in exceptionally rainy years, for there are 525 kilometers, as the crow flies, without water. It is in the eastern Sahara that the tanezrufts assume their most terrible aspect. Rosita Forbes and Hassanein Bey found 300 kilometers without water or pasture between the wells of Buttafal and Kufara. Hassanein Bey on his second journey traveled 430 kilometers without water between Owenat and Erdi.[28] A route to Kufara from the Unianga region (between Tibesti and Erdi) has been described by Tilho. This route has been made practicable by the sinking of the well of Sarra, by which the longest stretch without water has been reduced to about 180 miles, whereas it was formerly almost 300. The journey, however, remains troublesome

[26] See the note, "Ghardaia: A City of the Desert," *Geogr. Rev.*, Vol. 14, 1924, pp. 476–478.

[27] On other characteristics of the Algerian oases see E. F. Gautier, article cited in footnote 25.

[28] A. M. Hassanein Bey: Through Kufra to Darfur, *Geogr. Journ.*, Vol. 64, 1924, pp. 273–291 and 353-363. See also John Ball: Note on the Cartographical Results of Hassanein Bey's Journey, *ibid.*, pp. 367-386. Abstracted in this number of the *Geogr. Rev.*

by the total absence of pasturage for 500 miles.[29] The section of the route between Sarra and Kufara has at last been traversed by a European, M. Bruneau de Laborie in October, 1923. We quote from his narrative:

The landscape is monotonous in the highest degree. Each evening one has the impression that he is camping in the same place as on the previous evening. It is a kind of endless gravelly strand. To the west and to the east, however, in the far distance lines of relief appear. Those to the west at least are dunes; I could not see so clearly those to the east.

This uniformity of scene is broken only by skeletons of camels; but there are so many of them that even this becomes monotonous, hardly a kilometer without passing one. There are also human skeletons. This is the only desert country where I have observed such a feature. I passed seven or eight; and, as the paths are spread over a breadth of many kilometers, it is probable that there are many. These are the poor people who, as the Naji say, are eaten by the desert.[30]

This ever-present danger in such desert crossings has a powerful effect on the imagination. Here is M. Gautier's picture of the unconquered desert.

Consider the departure of a caravan on a route along which it is known that many others have found death and which sets out with advice on this order, "Keep the pole star well in line with your right eye and march all day until you have marked the evening star;" with the additional counsel "do not go too far to the west or you will go to the devil." Picture to yourself the interminable road across the *reg*, day after day watching for the mirage, which raises the horizon and enables one to see distant landmarks. Imagine the feelings of a traveler when there remains a half liter of water for 17 persons, and the guide has manifestly lost the path and the less reasonable members of the caravan eye him while fondling the butt of their rifles.

The natives of the Sahara know the danger of emotion in such critical moments; and they personify it in their legends. The desert has its voices: the abrupt change from night to day is sometimes accompanied with the noise or cries of the desert rocks. It was thus, as the ancients said, that the Colossus of Memnon saluted the dawn when struck by the first rays of the sun. The dune also speaks: some days, under the influence of the wind, or simply under the pressure of the human step it is put in a tremor; the myriad grains of sand rubbed lightly against one another utter a strange roar like the roll of a drum. For the natives these mysterious noises are the laughter of a jinn, whom they call Roul, the evil spirit who haunts the strayed traveler. When he has lost the path, when he is exhausted with fatigue, the atony of thirst and anguish of danger beginning to confuse his vision and paralyze his brain, then he hears the laughter of Roul.

The Oases and Transportation

Life in the oases is dependent not only upon water but upon transportation. Reference has been made to the transformation in desert travel to be anticipated by the introduction of mechanical transport. An earlier revolution was effected by the introduction of the camel. The camel appears to have been introduced into Egypt in the sixth century before Christ, but it did not spread to the western Sahara until the later Roman times. Some have seen in this an evidence of desiccation. But whether this is the case or whether it was a simple historical happening, the results were far-reaching. The Sahara was made a more habitable place both for

[29] Jean Tilho: The Exploration of Tibesti, Erdi, Borkou, and Ennedi in 1912–1917, *Geogr. Journ.*, Vol. 56, 1920, pp. 81–99; 161–183; 241–267; reference on pp. 94–95.

[30] Address of M. Bruneau de Laborie before the Geographical Society of Paris, *La Géographie*, Vol. 41, 1924, pp. 600–625; reference on p. 613.

nomads and for sedentaries, and habitable, furthermore, by a different race of people. Before the coming of the camel the scant population of the Sahara was black, Egypt excepted. Of this we have documentary and archeological proofs. The wave of white migration advanced southward by slow stages and is in fact still continuing. Kufara (the name signifies "pagan") was conquered only towards the end of the eighteenth century. There are still parts where the white nomad and the palm cultivations associated with him have not yet made their appearance. In passing, reference may be made to a physical cause contributary to the habitability of the Sahara by the white man—the low temperatures experienced in the winter months, which also are responsible for the diffusion of certain species of dates, justly accounted the most merchantable.

The Future

European intervention in northern Africa has already made itself felt economically. The salt of the Sahara, Taudeni for instance, encountering the competition of the European product, now finds only a limited market in the Sudan; European stuffs are causing the disappearance of native trades, but it was especially the suppression of slavery and the slave trade that struck a mortal blow at the old trans-Saharan commerce. Loss of trade in the oases has had its effect on the nomads whose natural tendency to pillage was increased. On the other hand European occupation has had a compensatory effect in the establishment of law and order. Artesian wells sunk by European methods have multiplied, and an impetus has been given to the cultivation of dates. This movement will continue. Over large areas conditions are theoretically suitable for the sinking of artesian wells; it is rather remarkable that no new artesian region has as yet been found. Although an anciently known region, exploration will be necessary to determine mining possibilities. On the Sudanese borders, especially in the Niger bend, agriculture may take on a great development.

One must guard against exaggeration in estimating the possibilities that the future holds; the greatest desert of the world will not lend itself as a whole to serious exploitation until man discovers the secret of rain making. Undoubtedly some power can be drawn from the great unutilized forces of the desert—solar energy and wind; but, as far as we can see, in its essentials "le Sahara restera le Sahara."

EFFECTS OF TROPICAL CYCLONES UPON THE WEATHER OF MID-LATITUDES

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All parts of the world have somewhat irregular changes of temperature, wind, and precipitation from day to day; but in middle latitudes such changes are especially marked. The immediate causes of changes of weather are the passage of highs, or anticyclones, and lows, or cyclones, variations in the number and intensity of these cyclonic storms, the location of the paths followed, and their speed of movement. There are several hypotheses concerning the influences which produce these changes in cyclonic storms. The chief purpose of this article is to add another, namely, that tropical disturbances, particularly tropical cyclonic disturbances, give rise to many of the irregular weather changes of the rest of the world. Before taking up this new hypothesis, however, it will be worth while to outline other hypotheses.

Old Hypotheses as to Causes of Irregular Changes of Weather in Mid-Latitudes

One hypothesis of the cause of variations in the courses, intensity, and velocity of mid-latitude cyclonic storms is the so-called "accidental variation" in the distribution at any time of cloud cover, of snow-covered land, and also of dry land that can be readily heated by the sun. The convection over the abnormally warm areas develops slightly lower air pressures. Since cyclones are attracted by abnormally low pressures, the next migrating cyclone that comes near is likely to be deflected into the abnormally warm area. Conversely, the cooler regions tend to become places of higher pressure and to "repel" lows and "attract" highs. But during the clear weather and low humidity characteristic of a high the snow or excessive moisture in the soil may disappear, and the area that was relatively cold soon becomes warmed by the sun and may attract an on-coming low. Likewise, the abnormally warm area may be made relatively cold by the rain or snow brought by the cyclone it attracted. Thus there would be constant shifting in the courses of the storms. Variations in velocity and intensity also would be caused by changes in the pressure gradients and in the contrasts between adjacent regions with respect to temperature and pressure.

Another hypothesis to explain the almost constant change in storm tracks and intensity is that the variation in mid-latitude cyclonic storms is a result of the interaction of the storms themselves, which race eastward crowding one upon the other. They may be compared to a troop of unacquainted animals going in the same general direction along a lane but with

no well-defined purpose in mind. There would be many close approaches and not a few crossings of paths and variations in velocity. If we imagine new members springing into existence in the midst of the moving throng, and many of the older ones disappearing, the analogy to what happens in the storm belts becomes still closer.

The counter-current hypothesis assumes that the cyclonic storms are eddies produced from time to time chiefly between masses of air moving poleward and masses moving equatorward, but to a lesser extent where the westerlies encounter high mountains or other barriers. If many cyclonic storms have such an origin, a considerable variation in tracks would occur as the storms move eastward in the westerly wind belt, partly by the crowding mentioned in the preceding paragraph and partly by the variations in the masses of poleward air moving equatorward (the "Polar Front" of Bjerknes.)[1]

That the atmospheric circulation of high and middle latitudes is controlled by the polar and other large ice caps was suggested by Hobbs in 1911 and elaborated by C. E. P. Brooks and by Hobbs in 1914.[2] They paid special attention to the probable effect of continental glaciers on the atmospheric circulation during the glacial period. Sir David Mawson, the Antarctic explorer, however, definitely suggested that many of the weather changes of the south temperate zone are produced by storms that develop along the coast of Antarctica. Bjerknes' hypothesis of the Polar Front makes the equatorward movement of the cold air of high latitude a dominant factor in mid-latitude weather.

Another hypothesis emphasizes the so-called "centers of action." According to it, the irregularity in storm tracks is mainly due to departures from normal of the air pressure in certain critical regions, chief of which are the vast areas of semipermanent high pressures in subtropical latitudes over the ocean. As these expand or contract, intensify or weaken, the migrating storms to the poleward are alternately repelled and attracted. A further complication is that sometimes the departures migrate far from their place of origin. Several investigators have correlated weather changes in distant regions with abnormal conditions at certain critical stations.[3] For example, C. F. Brooks and others report that a forecast having considerable value can be made several days or even weeks in advance in respect to the weather in winter along the eastern coast of the United States and

[1] V. Bjerknes: The Meteorology of the Temperate Zone and the General Atmospheric Circulation, *Monthly Weather Rev.*, Vol. 49, 1921, pp. 1–3.

A. J. Henry: J. Bjerknes and H. Solberg on the Life Cycle of Cyclones and the Polar Front Theory of Atmospheric Circulation, *Ibid*, Vol. 50, 1922, pp. 468–474.

[2] C. E. P. Brooks: The Meteorological Conditions of an Ice-Sheet and their Bearing on the Desiccation of the Globe, *Quart. Journ. Royal Meteorol. Soc.*, Vol. 40, 1914, pp. 53–70.

W. H. Hobbs: The Rôle of the Glacial Anticyclone in the Air Circulation of the Globe, *Proc. Amer. Philos. Soc.*, Vol. 54, 1915, pp. 185–225.

[3] Henryk Arctowski: The Pleionian Cycle of Climatic Fluctuations, *Amer. Journ. of Sci.*, Series 4, Vol. 42, 1916, pp. 27–33.

G. T. Walker: A Preliminary Study of World-Weather, *Memoirs Indian Meteorol. Dept.*, Vol. 26, Part IV, Calcutta, 1923. Reviewed by C. F. Brooks, *Geogr. Rev.* Vol. 14, 1924, pp. 657–658.

in western Europe by noting the departures from normal at Bermuda, a station in the midst of an important semipermanent high.[4] Likewise, the probable intensity of the rain-bearing summer monsoons of western India has been for the past several years predicted with considerable success some weeks in advance by a study of the pressure conditions far to the westward, in Palestine in particular.

Clayton has reported marked success in short-period forecasts of the weather in Buenos Aires on the basis of the daily variation in sun-spot activity as observed at the solar observatory in Chile. He has made forecasts on this basis for several years[5] and with sufficient apparent success to lead the Argentine government to relieve the Smithsonian Institution of the cost of maintaining this observatory. Hence, the sun-spot hypothesis is another explanation of weather variations. Evidence as to the close relationship existing between the sun and the weather has been advanced by several other investigators, including Helland-Hansen and Nansen[6] and Huntington[7]—Arctowski also is convinced that the changes in the centers of action are caused by solar changes.

The New Hypothesis

Now for the new hypothesis. The dominance of the tropics in the general so-called planetary circulation of the globe has long been recognized. The intense solar heating along the equator gives rise to the trades, which are the dominant winds of the tropical half of the globe. The westerlies, the prevailing winds of most of the remaining half, are due in part to the descent in higher latitudes of part of the air that rises along the heat equator after it has been turned far to the east by the deflective effect of the earth's rotation. The seasonal shifting with the sun of the belt of equatorial calms, the doldrums, and the resulting winds cause many of the gradual changes in weather from week to week as the seasons pass, not the irregular changes now under discussion. These latter, however, may be partly explained by irregular variations in the amount of air rising in the doldrums; since, accompanying any increase in the amount of air expanding and rising along the equator, there is a strengthening of the trades and later of the westerlies. Related to these are changes in the pressure in the subtropical semipermanent high-pressure centers of action, with consequent alteration in the storm tracks in higher latitudes. That there are variations in the amount of air rising along the equator seems highly probable now, since we know that the sun gives out continually varying amounts of energy.

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4 C. F. Brooks: Ocean Temperatures in Long-Range Forecasting, *Monthly Weather Rev.*, Vol. 46, 1916, pp. 510–512.

5 H. H. Clayton: Variation in Solar Radiation and the Weather, *Smithsonian Misc. Colls.* Vol. 71, No. 3 Washington, D. C., 1920.

Idem: World Weather, New York, 1923.

6 Björn Helland-Hansen and Fridtjof Nansen: Temperature Variations in the North Atlantic Ocean and in the Atmosphere, *Smithsonian Misc. Colls.*, Vol. 70, No. 4, Washington, D. C., 1920.

7 Ellsworth Huntington: The Earth and the Sun, Yale University Press, 1923.

Unfortunately, the existence of widespread fluctuations in the amount of air rising along the heat equator is not yet demonstrated, though such fluctuations are very strongly suggested by the occurrence of the surges of pressure that frequently move across Australia from the tropics poleward[8] and also by marked variations often noted in the strength of the trades over extensive regions.

Another reaction to the varying amounts of energy received from the sun may be tropical cyclones. As these commonly pass from near the heat equator to higher latitudes they carry away vast quantities of energy, chiefly in the form of latent energy of water vapor.

Tropical Cyclones: Distribution and Frequency

Tropical cyclones have been known for centuries, and accounts of experiences in severe storms are very numerous. Yet, so far as I know, no one has given much consideration to their wider relations. Indeed, they appear not to have been suspected of having more than local and temporary meteorological importance. The chief reason why they have been so ignored is because they were thought to be rare phenomena. Instead, as we now must realize, they are numerous and widespread: several tropical cyclonic disturbances occur each month in the year somewhere; and in the summer and autumn large parts of the tropics are profoundly affected, and also many parts of higher latitudes. Destructive tropical cyclones have occurred every month in the year in the Far East, in the Bay of Bengal, and in Australia; and in all but one or two months they have occurred in the South Indian Ocean, the South Pacific, and in the eastern North Pacific. In the West Indies they are very rare in the first four months of the year, Mitchell reporting none in the last thirty-six years; but Poey's long record includes examples. The more the records of storms are studied, the more widespread their distribution among the months is found to be in all regions. Moreover, although destructive hurricanes are rare in certain parts of the tropics and are rare everywhere during winter and spring, less severe storms of tropical origin are not thus closely limited. Fortunately, few tropical cyclonic storms cause much destruction; and, although some cause gales simultaneously over an area several hundred miles across, most of them demolish a zone only a few score miles wide, and some are only a few leagues wide. Then too, the tracks followed differ so much that any given locality may be hit disastrously only at considerable intervals, even in the stormiest regions. Furthermore, in general only the more violent storms have been considered worthy of mention. A false local pride sometimes leads residents of storm-affected regions to be as silent as possible even about storms that were violent enough to demolish practically all houses in the district. Hence arises the erroneous impression that tropical cyclones are rare phenomena.

[8] E. T. Quayle, of the Central Meteorological Office, Melbourne, has made special study of these (oral communication).

Table I shows the average number of recorded tropical cyclones occurring yearly in certain regions.

TABLE I—AVERAGE ANNUAL FREQUENCIES OF RECORDED TROPICAL CYCLONES

REGION	HURRICANES	CYCLONES	CYCLONIC DISTURBANCES
Far Eastern Pacific (110° E. to 140° E.)	10	20	50
Central North Pacific (140° W. to 140° E.)	2	4	?
Eastern North Pacific (east of 140° W.)	2	3	?
South Pacific (130° W. to 160° E.)	5	10	10
Australia and Coastal Seas (110° E. to 160° E.)	5	8	10
South Indian Ocean	8	5	?
Arabian Sea	2	2	?
Bay of Bengal	2	6	2+
West Indies, etc.	3	2	2+
	39	60	74+

Most of the data upon which this table is based are discussed elsewhere.[9] However, the source of the large figures for lesser tropical disturbances given for the Far East and Australia deserves comment here. For Australia the daily weather maps covering thirty years were studied. The large figures for the Far East are also based on a study of the daily weather maps, especially those issued by the Japanese Imperial Marine Observatory, Kobe, in 1920 and 1921. In a weekly summary of weather conditions Dr. Okada plots and numbers the storm tracks. The disturbances of obvious tropical origin have been selected from his tracks. The total of well over one hundred tropical cyclones occurring yearly, on the average, in longitudes 110° E. to 160° E. (less than one-seventh of the circumference of the globe) certainly is surprising. Nearly all of those shown by Okada pass out of the tropics into higher latitudes, usually not as destructive hurricanes but, nevertheless, as distinct disturbances. In the light of such numbers, who can maintain that tropical disturbances have only local significance? Although these far eastern longitudes yield a large fraction of the total given in Table I, it is because only recorded storms are included, and most of the lesser disturbances escape record elsewhere. For only one other extensive part of the tropics are daily weather maps made, namely, the West Indies; and they are not published.[10] The future may prove that, except in longitudes 110° E. to 150° E., there are more than twice as many tropical

[9] S. S. Visher: Tropical Cyclones in Australia and the South Pacific and Indian Oceans, *Monthly Weather Rev.*, Vol. 50, 1922, pp. 288–295.

Idem: Tropical Cyclones in the Northeast Pacific, between Hawaii and Mexico, *ibid.*, pp. 295–297.

Idem: Notes on Typhoons, with Charts of Normal and Aberrant Tracks, *ibid.*, pp. 583–589.

Idem: Tropical Cyclones of the Pacific, *Bernice P. Bishop Museum Bull.*, Honolulu (in press).

[10] The Indian Government now publishes a daily weather map including the Bay of Bengal which, since most ships carry radios, should be valuable in this connection. The writer, however, has not had access to a series of these maps.

disturbances a year as are shown in Table I. One reason for this belief is the large percentage of winds from abnormal directions in the trade wind belt shown for each five-degree square on the monthly pilot charts issued by the Hydrographic Office at Washington. The wind roses were prepared by the U. S. Weather Bureau from all available ship logs. It will be noted that Table I gives annual averages. The number of storms in any area often fluctuates sharply, one year having perhaps two or three times as many as the next.

Effects of Tropical Cyclones Upon the Weather of Middle Latitudes

The effects of tropical cyclones upon the weather of mid-latitudes are both direct and indirect. The direct effects are partly the same as those produced within the tropics and are partly different. Among those that are the same, mention may be made of the changes in air pressure, wind direction and velocity, cloudiness, humidity, and precipitation. For example, the tropical cyclones bring the lowest pressures to southern Australia and to the United States, and also the strongest winds aside from those in tornadoes. They also cause the heaviest widespread rainfalls. Effects that differ from those produced within the tropics are the conspicuous differences in temperature and a wider zone of influence.

As a tropical cyclone advances from the tropics into middle latitudes it produces a series of marked changes of weather. At some distance to the northwest of the center, in the northern hemisphere, cool northwesterly winds, clear skies, and fine weather generally prevail. Nearer the storm center, cloudiness, heavy rainfall, and strong gusty winds are the rule. Thus tropical cyclones that move northward some distance from the eastern coast of China or the United States bring to those regions fine spells of weather, then rain and strong winds. For example, two tropical cyclones that moved almost simultaneously from the Caribbean Sea and the Gulf of Mexico northward to Southern Canada and thence northeastward in October, 1923, brought the eastern half of the United States most of the rain received in that month and produced several consecutive rainy days.

The encircling winds of tropical cyclones produce notable changes of temperature in middle latitudes. The winds from the south, on the eastern side of the center in the northern hemisphere, bring northward large quantities of tropical heat and moisture. Some of the most oppressive spells of hot weather in Japan are associated with tropical disturbances that pass northward to the west of those islands. Similarly in Australia, tropical disturbances that pass southward some distance inland bring oppressive, muggy weather to the eastern cities. On the opposite side of cyclonic disturbances, however, the wind is from higher latitudes and hence cool and relatively dry. In Australian weather reports there is frequent mention of tropical disturbances ending a long sultry spell of weather. Similar

welcome changes of weather occur frequently in the early autumn in eastern China and Japan as well as in the United States whenever tropical cyclones pass northward at some distance from the coast.

Indirect Effects

The indirect effects of tropical cyclones upon the weather of middle latitudes are of three main types, those due to disturbances in the normal planetary circulation, those due to disturbances in the so-called permanent "centers of action," and those due to the influence of the tropical storms themselves upon other cyclones in middle latitudes.

The normal planetary circulation is disturbed by the lowered surface temperatures produced by the dense canopy of clouds, the active evaporation occasioned by the strong winds, and the agitation of the sea. As evaporation requires much heat, the surface of the ocean is cooled appreciably by the hurricane winds. The cooling is increased by the fact that the canopy of clouds decreases insolation greatly. The latent energy in the resulting vapor is released at relatively high altitudes, where condensation takes place, or is used up in moving air or water. In any case it is largely lost so far as surface warmth in the storm area is concerned. The agitation of the sea also results in lower surface temperatures, since the water at even slight depths is decidedly cooler than the normal surface water of the tropics, and breaking waves cause a mixing of the water.

At the same time that the surface temperatures are reduced the temperatures at considerable elevations in the atmosphere are increased, owing to the release of latent energy when condensation takes place.[11] Therefore a tropical cyclone at first accelerates the rise of air in low latitudes and in so doing speeds up the planetary circulation. But after the storm has passed out of low latitudes or has died out much less air rises in that portion of the doldrum belt than is normal. Hence the trades and antitrades are slowed up, and far-reaching effects are produced upon the extra tropical high and westerlies. The abnormally cold surface-water conditions produced by tropical cyclones may last for weeks or even months and may be carried, with lessened intensity, into remote regions by general ocean currents. For example, C. F. Brooks [12] and others report significant effects upon the weather of northeastern United States and northwestern Europe of abnormally cold surface waters in the Gulf Stream and related drifts weeks or even months after such departures have been produced in the West Indian region. Recently the effects of surface-water temperatures of the Gulf of Mexico upon the winds and rainfall of Texas have been effectively pointed out by Tannehill.[13]

[11] This increase is shown by numerous balloon data. However, soundings also show that at great heights in a cyclone the air is abnormally cold. This apparently is due to the effects of inertia, the upward-moving air having ascended beyond the level of equilibrium.

[12] *Loc. cit.*

[13] I. R. Tannehill: Influence of Gulf Water-Surface Temperatures on Texas Weather, *Monthly Weather Rev.*, Vol. 51, 1923, pp. 345–347.

Another effect that is not local is that exerted upon "centers of action." When a hurricane passes near a semipermanent high, such as the Bermuda high, much air is drawn from it and distributed elsewhere. Hence the intensity of the high is reduced, and its shape and position are changed.[14] The tracks of storms far away, even on its opposite side, are thereby affected. Likewise the slowing up of the normal planetary circulation, mentioned above, means that the amount of air rising along the doldrums is reduced and that the antitrades are weakened. In turn, the amount descending is lessened, and the belts of high pressure in latitudes 25° to 35° do not receive their normal amount and are weakened. The irregular variation in the height and velocity of the antitrades reported by Fassig from Porto Rico and by Daingerfield from Honolulu may be caused partly by such disturbances. The so-called "belt of high pressure" is completely severed whenever a depression migrates from the tropics to higher latitudes; and this happens nearly a hundred times a year, as we have seen, in a segment comprising only a seventh of the earth's tropical circumference.

Effects of Tropical Cyclones Upon Other Cyclones in Middle Latitudes

Cyclonic storms already moving eastward in mid-latitudes are deflected from their previous course by the newcomers, the lows often being attracted and the highs normally repelled. After the tropical disturbance has come into high latitudes it becomes indistinguishable from other cyclonic disturbances occurring there unless characterized by greater intensity. The stronger storms, be they recent arrivals from the tropics or extratropical storms reinforced by newcomers as they move eastward, are able to break through barriers of high pressure that can stop or at least divert weaker storms. The daily weather maps for the northeastern Pacific often show the effect of such impacts. The map for December 16, 1921, completed weeks later by Mr. Daingerfield, then in charge of the Hawaiian Section of the U. S. Weather Bureau, shows a tropical cyclone, traceable on Philippine and Japanese maps from the Carolines on December 8 to east of Japan on the 12th, impinging against the great high that had prevailed far south of Alaska for some days. The pressure increased east of the storm as it advanced. The storm broke through the barrier of high pressure on December 17, and its later phases can be traced on the United States Weather maps across the United States.

Conclusion

In conclusion, let us return to the hypotheses mentioned in the earlier part of the article. The first (accidental variation) doubtless has local value in forecasting; but, as many recognize, it does not explain the wider

[14] See Plate 17 in O. L. Fassig: Hurricanes of the West Indies, *U. S. Weather Bur. Bull. X*, 1913.

variations from year to year. The second (jostling of storms) certainly has real value, and it is not at all contrary to the new hypothesis, which supplies an explanation as to the source of many of the new storms. The third (the counter-current hypothesis) helps explain the mechanics of the origin of some storms but by no means all. The fourth (that influences emanating from ice caps control weather) may be true locally but certainly is not true for most of the earth, since such storms never move far equatorward, and few or no storms enter the tropical half of the world from higher latitudes. The hypothesis of centers of action certainly has great value, and it fits in with the new hypothesis, which supplies an explanation as to how variations in the centers may be produced. The solar hypotheses, likewise, are aided by the new hypothesis, provided variation in the number of tropical cyclones is related to solar changes of some kind, and this seems to be the case at least in certain large regions.[15]

Thus it appears that the hypothesis that tropical disturbances, and particularly tropical cyclonic storms, have an important influence on the weather of all latitudes is worthy of serious consideration, since it takes into account important phenomena hitherto ignored and helps explain much not heretofore satisfactorily explained.

The gathering of sufficient data to test adequately this hypothesis will require much time and coöperation. Information as to any data having a bearing on it will be greatly appreciated.

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[15] S. S. Visher: Sunspots and the Frequency of Tropical Cyclones, *Amer. Journ. of Sci.*, Ser. 5, Vol. 8, 1924, pp. 312-316

PLANS FOR EXPLORATION AT THE HEADWATERS OF THE BRANCO AND ORINOCO

By A. Hamilton Rice

The Topographical Objective

The first main object of the present expedition in the Amazon Basin is topographical: to carry out a survey of the Rio Branco from where it debouches into the Rio Negro to its branches, the Uraricuera and Tacutu;

FIG. 1. Map showing the general location of the region of Dr. Rice's present explorations.

to follow up its first-named western tributary to its sources, the Parime and Auari; and to cross from one of these over the Serra Parime to the main source of the Orinoco. Indians of the upper Orinoco have told me of a path leading from the Orinoco to the Parime branch of the Uraricuera that is used by the Guaharibos in passing from one river system to the other. It was while attempting to reach the main source of the Orinoco in 1920[1] that my small party was blocked by a band of Guaharibos at a point known as the *raudal* (rapids) Guaharibos, not improbably the scene of the historic encounter with forces of the Spanish Boundary Commission under Francisco Bobadilla in 1763. This encounter, a combat without much honor to the Spaniards, was apparently the cause of the unending hostility of the indigenes who, true to their mandate that all—white and Indians alike—ascending the river should be attacked, have for 160 years successfully repelled all invaders entering their domain. The bridge, whether in commis-

[1] A. Hamilton Rice: The Rio Negro, the Casiquiare Canal, and the Upper Orinoco, September 1919–April 1920, *Geogr. Journ.*, Vol. 58, 1921, pp. 321–343.

sion or not, is ceaselessly guarded and is the dead line beyond which none may pass. Humboldt was deterred from attempting it by the authorities at Esmeralda and his poor physical condition. Codazzi, the valiant Italian, is said to have been repulsed. Spruce's Venezuelan allies failed to reach Esmeralda. Schomburgk crossed from the east too far to the north and was outside the danger zone on the Padamo, by which route he reached Esmeralda. Rojas y Michelena ascended to the mouth of the Rio Umauaca only. Chaffanjon, the Frenchman, in 1886 actually succeeded in passing the *raudal* Guaharibos and ascended slowly and laboriously for several days more. He claimed to have reached the source; but Caripoco, a Maquiritare Indian, the only surviving member of Chaffanjon's crew and a member of mine in 1920, assured me that they did not reach the source and that the river was a deep, narrow *caño* when they turned back, at which point it showed no signs of coming to an end.

Chaffanjon had a sextant, but it is unlikely that he knew how to use it as his sketch map is uncontrolled by any points determined astronomically: it is merely a rough compass traverse plotted by estimated time and distance naturally largely in error.

There is no mention of the trend of the serras which, according to Caripoco, cross the river from a northeast-to-southwest direction, which is just as would be expected and not the absurd north-and-south direction indicated today on the best and most conservative British, French, and German maps. The Serra Parime is undoubtedly one and the same with the Serra Taapira Pecu, which in turn is responsible for the great reefs that make the series of *caxoeiras* from the mouth of the Caiary-Uaupes to Camanaos on the Rio Negro and further to the southwest rise into hills again around the bases of which the Rio Marie winds.

In topographical work east of the Andes it is important to bear in mind the value of recognizing from a single hill or discrete elevation, the possibility of scarps, terraces, and lines of hills. The maps, ancient and modern, and the authors, early and recent, that I have examined fail in this matter of physiographic interpretation.

Methods of Survey

Of the methods of survey, the usual one of a compass traverse by means of time and distance scales checked by astronomically determined latitudes, longitudes, and azimuths, together with wireless time signals, will be further supplemented by aerial photography.

A specially constructed hydroplane, Curtiss Sea Gull type, with Fairchild camera and wireless apparatus, has as pilot Walter Hinton, of NC-4 renown, and as engineer John Wilshusen, who last year accompanied Hinton in this capacity on the flight from New York to Rio de Janeiro. Captain A. W. Stevens of the Air Force Section of the Army will have charge of the aerial photography. He has achieved some notable results in the western states. Aerial photography as a supplement to ordinary survey is of the

greatest value in augmenting the detail data on either side of an ordinary route traverse. In those districts where either the hostility of the natives or the natural physical obstacles are such as to delay progress of an expedition or effectually to check its ingress, aerial photography may be resorted to by the explorer as wireless has solved the heretofore perplexing matter of obtaining satisfactory longitudes in the field.

In the present case, for instance, the source of the Orinoco is about one hundred miles north of Barcellos. By allowing for the compass variation, which is 13° 40′ W., a course can be set from Barcellos, where the Rio Negro is ten or twelve miles wide and affords a good take-off for the plane in spite of the islands. A reconnaissance trip can be made over this area, photographs obtained, and return to Barcellos accomplished within a few hours, yielding information of the greatest value: such as the trend of the mountains, the possibilities of traversing them, the distance between the sources of the Orinoco and the Parime tributary of the Uraricuera, the number of Guaharibo clearings, and evidence of habitations. The south-to-north flight from Barcellos to the source of the Orinoco may be further augmented by turning east from the Parime Serra and crossing to the Branco where the country is supposed to be of a more open and plain-like character.

Provision will be made for developing the films as soon as possible after exposure, that is on the night of the day on which they are taken.

The wireless work is in charge of John W. Swanson, of New York, a radio inspector who accompanied the expeditions of 1916–1917 and 1919–1920 as wireless operator. All of the apparatus has been assembled and put together by Mr. Swanson and his assistant, Mr. McCaleb, and is in three parts, or sections. The largest, destined for the base camp to be established on the Rio Branco at a spot near Boa Vista, is designed to transmit as well as receive, as is the wireless equipment of the hydroplane, whose transmitting power, however, is limited by necessity to an area of fifty miles. The wireless instrument for the survey party is for receiving only, its principal function being, of course, the reception of wireless time signals.

Inasmuch as surveys over regions like Brazilian Amazonas and Venezuelan Guayana are limited to such traverses as have been mentioned, and inasmuch as any such rigorous method as triangulation is impracticable, especial attention is paid to the frequency, accuracy, and most expeditious means of astronomical observations for the determination of latitude, longitude, and azimuth. These are of vital importance, as by them the errors of the daily traverses are corrected, and they form the framework upon which the map is constructed.

During the long so-called dry season many of the nights are overcast by great cumulus clouds. On such occasions during the 1919–1920 expedition Mr. Chester Ober, of the U. S. Coast and Geodetic Survey, and I often resorted to the St. Hilaire, or "New Navigation," method for obtaining our latitudes and longitudes. This method was suggested to me by a passage in a volume by Arthur R. Hinks, Secretary of the Royal Geographical

Society.[2] Observations by this method in conjunction on favorable nights with observations by the time-honored practice of separate pairs of north and south stars and east and west stars for obtaining latitude and time respectively, were found to compare most favorably and show that the method can be relied upon to give excellent results.

Upon our return from South America I had read with much interest of the work that Dr. John Ball and Mr. H. Knox Shaw had been doing in Egypt with the astrolabe, and I later had the opportunity of working several evenings with M. Claude in Paris and having him demonstrate his astrolabe *à prisme*. Mr. Reeves, of the Royal Geographical Society, has ingeniously devised a prism that may be fitted to any theodolite so that all the advantages possessed by an astrolabe are thus obtained for the theodolite, which, in addition to its greater diversity of use, is much more portable than the astrolabe *à prisme*. Mr. Weld Arnold, who assisted Mr. Reeves in this work, accompanies the present expedition as topographer. He and Mr. O. M. Miller, of the American Geographical Society's School of Surveying, have prepared lists of suitable stars with their times and azimuths for use with the prismatic astrolabe attachment fitted to the theodolite.[3]

It will be interesting to see to what extent, under such variable conditions as prevail in tropical South America, this really accurate instrument is practicable.

Study of the Natives

The second main object of the expedition is to continue the investigations of the indigenes along more extensive lines than it has heretofore been possible to pursue. This includes as thorough a medical survey as possible of the Rio Negro region, a work under the direction of Dr. Richard P. Strong, whose researches and achievements in the Philippines, Serbia, and Manchuria are internationally known, and with the aid of Dr. George Shattuck and several efficient assistants of the Harvard School of Tropical Medicine.

Since 1905 Dr. H. Wolfersham Thomas, who first went to Manáos to combat yellow fever, has carried on, single-handed and unrecognized, medical investigations and researches that are of the highest importance to tropical medicine in general and to the welfare of the people of Amazonas in particular. To the Brazilian federal authorities Dr. Thomas has been both help and inspiration; his experience and ability in handling such diseases as yellow fever, malaria, and hookworm render his services of the utmost value in the intermittent campaigns that are being carried on to stamp out

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[2] A. R. Hinks: Maps and Survey, Cambridge, 1913, p. 62.

[3] The object of the star lists is to dispense with the necessity of computing star observation programs in the field before making observations by the "Equal Altitude" method.

Lists for each degree of latitude from 3° S. to 5° N. have been computed by a graphical method devised by Mr. Miller and contain between 900 and 1000 observation times for each degree, or in other words an average time interval of less than two minutes between every two observations.

The stars are arranged in the order of their L. S. T. of observation, which is given together with their R.A.'s to the nearest minute of time. The azimuths are given correct to the nearest quarter of a degree, and an indication is added as to whether a star is listed in the American Ephemeris, the British Nautical Almanac, or the French "Connaissance de Temps," together with its magnitude.

these scourges. Yellow fever has practically been deleted from Manáos and Para, while malaria and hookworm are being spasmodically combated. The foci of these evils are many, and the grisly troupe that follow in their train deplorable in result. Manáos can never be free of them until the surrounding country is rid of the contaminating causes. That is to be consummated through education of the people in the laws of hygiene and sanitation. The question of population of the Amazon valley is not so much one of immigration of foreigners as of conservation of the indigene. No Chinamen, no Scandinavians, no Germans, no Italians, or other Asiatics and Europeans can ever take the place of the native race, which is preëminently fitted, by adaptability to environment and by inherited characteristics, for developing the resources of the country.

Let us glance for a moment at what may well be called the São Gabriel experiment—the substitution of elementary education for religious dogma, the coördination of physical and mental effort by means of agricultural as well as common schools. In the spring of 1918 at the request of His Excellency, Senhor Domicio da Gama, Brazilian Ambassador at Washington, I wrote the following letter, stipulating that it should be an open letter and reach as many Brazilians as possible.

My dear Ambassador:

Pursuant to our discussion the other evening I am sending you a written statement on what seems to me to be significant as an opportunity, which, if taken advantage of, may be of great moment and importance to the future prosperity and welfare of Brazil.

A few months ago there appeared in the magazine "Americas" an article relative to the colonizaton of those great fluviatile wildernesses of the Amazons, written by one who thinks and knows apparently only of the rubber which may be gathered there. His optimism was undampened by any realization of the truth that the indigene in numbers is diminishing by an inexorable law of nature because the simplest precepts are ignored or unrecognized by the authorities, and without the indigene the question of colonization and labor is a serious and well-nigh hopeless one. The settling of the United States and Canada by a steady stream of immigration from the European countries was a far different proposition to the corollary of peopling the Brazilian Sertão with a race by whose labor and industry the vegetable and mineral wealth may be exploited and the naturally rich land utilized for various crops.

During February of 1917 my party was detained several weeks at São Gabriel, upper Rio Negro, and I was much interested in comparing conditions of the village at that time with those of two previous visits in 1908 and 1913 respectively. Improvement there was, though undeniably opportunity existed for still greater.

Since my visit in 1913 a mission under the direction of the Salesian Fathers had been inaugurated, thereby quickening the religious sentiment and spiritual feeling of the place and imparting renewed life to the diminutive church and its equally tiny detached belfrey of clinking bells. Padre Lourenço Giordano, *prefeito apostolico* of Rio Negro (Amazonas) is the head of the mission, and Revmo. Sr. Padre Joao Balzola is his coadjutor. Both men have worked for many years in the Brazilian wilderness converting to Christianity the Indians, leading lives of noble example and unaffected humility, true missionaries.

Padre Giordano was the easier and more interesting to talk to, perhaps because older in years than his confrère, and of greater liberality in his viewpoint in consequence of a more prolonged acquaintance with the outside world. Furthermore, we had a common interest in the Caiary-Uaupes and the Içana Rivers, explored by me in 1908 and 1913 respectively,

and he having returned from a visit to their lower courses a few days after my arrival in São Gabriel. . . . . .

He amiably agreed that linguistic study rather than ecclesiastic would avail more to the indigene children, and I found him a ready disciple to my belief as opposed to that of Martius and the early missionaries, who were strong advocates for instruction in the Tupi language, reasoning that an autochthonous race would then not regard the white men as strangers or intruders but might easier be assimilated or won over by the higher cultivated white race and join them in large numbers. Such has not been the case, but rather a retreat before the whites with ultimate vanishment which if allowed to go unchecked means annihilation of the most valuable ally nature has furnished for the future working of a country, the magnitude of which excites imagination. "They are not helped because they do not progress. . . . They do not progress because they are not helped," so says Keller, a traveler of half a century ago in commenting on the vicious circle.

Schools should at once be instituted and the teaching of the Portuguese language made compulsory. Possessed of this, a consciousness of power and pride are engendered, a sense of duty and feeling of responsibility are felt, the individual becomes trained into the civilian, and the state is the richer by a valuable and loyal citizen who by the very reason of the mental evolution is then an infinitely better subject for ecclesiastical consideration and conversion.

Padre Giordano pleaded that such sentiments had more than once been put before the Church authorities but that it was not possible to get money appropriated for such a measure, and the monetary allotments were so miserably small as barely to suffice for running expenses as they were, and absolutely precluded the possibility of taking any initiative.

He was exultant and pledged himself to teach Portuguese to the two dozen or more little Indians of both sexes in São Gabriel, on my volunteering that my wife and I would gladly institute a school there, imposing only the condition of instruction in Portuguese, instruction in reading and writing it as well as speaking it, which last the Indian readily does after a little.

Not only in São Gabriel have I heard Indian mothers clamoring for a school for their children, but in other villages far distant from it.

From Manáos were sent up Portuguese school readers, arithmetics, geographies, and histories of primary and secondary grade, stationery, pencils, rubbers, crayons, blackboards, pens, and ink. . . . .

Stress is laid on the school paraphernalia not only because of the much more practical results that may be obtained from the employment of such necessary equipment and material, but also because of its paramount importance in the influence exerted for good in the moral and mental effect produced on the pupils. Their minds are at a sensitively impressionable stage, and everything is acutely felt. These are the very things that go to convey a visible, tangible force of civilization. They are objective, first of curiosity, then of interest, which last once aroused and sustained means success.

The panoply of school conduces to organization and discipline, and if any good is to be accomplished a firm and insistent policy must be carried out, universal in its application, for sporadic efforts will avail naught. By this elementary training and arousing ambition the mental pestilence of Indian lethargy and indolence will be destroyed, and by eliminating ignorance, superstition will be eradicated. . . . . . .

I have on my table a report just received from Colombia entitled "Informes sobre las Misiones del Caqueta, Putumayo, Coajira, Casanare, Meta, Vichada, Uaupes, y Arauca." La Junta de Misiones has as its president the Archbiship of Bogotá, and two of its sponsors are the President of the Republic and the Papal Nuncio of Colombia, State and Church working together for the common good. The reports from the missionaries themselves are to me, who know well the savage wilderness wherein they are working, deeply impressive and stirringly inspiring, especially the several letters sent from the Rio Cuduyari by Pedro Baron to the Archbishop of Bogotá. The narration of the ravages of an unrecognized disease among the Indians and the heroic but ineffectual efforts of the missionary to control it and

start his school cause an oft-repeated reflection on my part of the necessity also of medical education for a proportion of the priests and missionaries who consecrate their lives to the salvation of the South American indigene, if the greatest good is to be obtained.

The Rio Cuduyari while geographically nearer Bogotá than Manáos is less difficult of access from the latter, and only two days below its mouth the boundary of Colombia and Brazil is marked by the Kerari. North and south and to the east of the river are great communities of Indians whose salvation and redemption are earnestly to be desired and imperative for the welfare of Brazilian Amazonas.

The Rio de Janeiro Government ought to take example from the Bogotá authorities. I have usually found the *superintendentes* and *intendentes* of Amazonas a very intelligent, well-informed, progressive set of men whose services could be utilized together with the mission priests, and a work of stupendous importance and unalloyed blessing carried out along civilizing lines if intelligently directed by the central Government.

Couto de Magalhães' volume "O Selvagem" (edition of 1876) should be republished and used by those officials and missionaries whose labors will be in the valley of the Negro and its affluents. The cheap edition (1913) now published and sold in Pará and Rio de Janeiro is as worthless as the complete 1876 book is valuable. Of the many dictionaries and grammars of Tupi-Guarani or Nheengatu, the 1876 edition is the most correct, easiest, and most practical for the learner to acquire a dialect with which he can converse easily with the indigenes of an area of more than 5,180,000 square kilometers. It is at present next to impossible to obtain a copy of this valuable book either in Pará, Rio Janeiro, London, Paris, Madrid, or Lisbon, but it would be an easy matter for the Government to have it issued.

In this way a great amount of time may be saved to those whose task will be to instruct Portuguese to the indigene children, and this is of course only possible after acquiring a mastery of the indigene's own tongue.

It is foolish to deny that there is any other way to the cherished goal sought than by the hardest kind of self-sacrificing and self-effacing work, to be achieved only by strong men and women actuated by a high ideal and obsessed by a spirit of true missionary zeal and patriotic feeling. I include women, for it is a field wherein wide scope is possible for efforts on their part in all four subjects, religion, education, agriculture, and sociology.

I know Brazil and the Brazilians, their high sense of national honor, their humanity and hospitality, their sympathetic understanding, and their national asset of amenity. Patriotism and democracy, political freedom and religious liberty are dominating notes of the national character that splendidly exemplify the best ideals and traditions of the Western world, and because of these I believe Brazil can do as useful, practical, and profitable a piece of colonizing and civilizing work as the world has ever seen.

Very sincerely yours,

HAMILTON RICE

June, 1918

The school at São Gabriel was started late in 1917 with twelve pupils. The town at that time had a population of perhaps 400 souls. The school rapidly became popular not only with children but with adults; several sessions daily were necessary; and the truant officer's duty was transformed into one of police vigilance—to prevent the Indian children from the west bank from crossing the dangerous waters in bad weather, the *caxoeiras* of São Gabriel being the worst of the Rio Negro along its length of 1000 miles. Today the school has 275 pupils gathered in two buildings, one for boys, another for girls; there are also an agricultural school for boys and a training school of domestic accomplishments and nursing for the girls. In addition a hospital has been started, two doctors and four trained nurses

from Rio de Janeiro serving for a stated period and in turn being succeeded by another staff. The hospital is supplied with up-to-date equipment.

The population of the village has increased at an extraordinary rate. In 1919 the improvement due to favorable educative influence was beginning to be apparent. The manners of the children had changed from those of unkempt little savages to those of a well-ordered and civilized community, and general health was greatly improved. Cleanliness of houses and neatness of gardens, along with a general quickening, impressed the observer. There was considerable sickness on the lower river that year, malaria and influenza being especially prevalent; but São Gabriel escaped. Since that time the story has been one of steady progress and upward trend.

In December, 1919, Monseignor Giordano, the father in charge, died, an unrecorded hero, a man of great kindness of heart, of infinite patience and ability in his work. What he has done for the humble humanity of the South American wilderness may never be told, but in every way he deserves to be counted among that host of self-sacrificing missionaries who during the ages have consecrated their lives to such work.

A worthy successor to Mons. Giordano is Mons. Pedro Massa, under whose guidance and leadership the initial work of Giordano is being carried on and developed in a most gratifying and inspiring way. A practical man, possessing the training and experience necessary in such work and imbued with the missionary zeal and religious spirit that seem to inspire the Salesian Fathers, his initiative, energy, enthusiasm, and ability are achieving remarkable results.

Not many miles to the northeast of São Gabriel is the almost unknown country of the Orinoco and the Guaharibos, "Indios blancos" of the early Spaniards and Humboldt. They have faithfully and efficiently kept their ultimatum sent in proud and dictatorial way to the leaders, Iturriaga and Solano, of the expedition of the Royal Spanish Boundary Commission after the clash with Francisco Bobadilla.

Richard Spruce, in writing from Venezuelan Guayana to his patrons, Hooker and Tisdale in 1853, states that he is sending a Guaharibo vocabulary, a list of words he obtained from a captured Guaharibo whom he interviewed near the upper end of the Casiquiare Canal. A prolonged and exhaustive search by the curator of Kew and his assistants has thus far failed to disclose this valuable document, though the actual letter cited above has been located, as have all of the exquisitely neat and model diaries of Spruce, his manuscript notes, and other data.

Ethnologically the Guaharibos are of interest as extremely primitive people, who are anthropophagous, eat their food raw, and apparently possess no knowledge of fire. They have no dogs, live in circular houses on the communal plan, cultivate plantations during a part of the year, and for the remainder roam in bands over a savage wilderness bisected by the Parime serra.

GEOLOGICAL SIGNIFICANCE OF ISOSTASY AND GRAVITY MEASUREMENTS: A REVIEW*

By Chester R. Longwell
Yale University

"Very large regions, such as the wide ocean floors and very large divisions of continents, show in their gravimetric behavior only slight departures from the condition of gravity theoretically demanded [by the doctrine of isostasy]. . . . Adjacent to these regions of normal gravity there are numerous exceptions with pronounced variations from the theoretical normal conditions. . . . The essential thing is that where exceptions are found, we are nearly always in a position to suggest an explanation on the ground of the peculiar geological position of the district. It cannot be denied, however, that we are still far removed from a complete explanation of all gravity anomalies."

These brief extracts express some of the broader conclusions drawn by Dr. Born in his recent book on isostasy and gravity measurements. An adequate conception of this author's important work, however, can be gained only by careful study of the book, which contains a wealth of information presented in an analytical and practical form.

The literature of isostasy, already surprisingly large, is growing at a rapid rate in foreign languages as well as in English. A digest of all the available facts, whether geodetic or geologic, accompanied by judicious analyses and interpretations from a geologic viewpoint, is needed by every student of earth science. Exactly what has been and is being done in Europe and Africa, as well as in America and India, to determine gravimetric conditions? What significant relationships are known to exist between geologic structure and values of gravity? What geologic tests of isostasy may be accepted as reliable, and how may the larger facts of earth history be explained in accordance with the theory? Dr. Born's work goes far toward answering these and other important questions; not so much by advancing entirely original ideas as by welding together the most significant things already published into an eclectic treatment. The book should be of especial value in America, because it summarizes facts and ideas not otherwise available except by laborious search through European literature.

A Comparison of Method

In Europe, particularly in Central Europe, the net of gravity stations is many times denser than the net in the United States. Europe has thousands of such stations, and many of the observations are concentrated in districts of especial geologic significance, such as the Alps and the Harz Mountains.

* A. Born: Isostasie und Schweremessung: Ihre Bedeutung für geologische Vorgänge. 160 pp.; maps, ills. Julius Springer, Berlin, 1923.

A question arises as to the most effective method of using the gravity data for geological purposes. The Germans follow the lead of Helmert, and it has been supposed by many that they reject the reduction methods of Hayford and Bowie, so well known in America. Born makes it clear, however, that the Hayford-Bowie method is held in high regard as a means of testing the theory of isostasy. Reduction to a minimum of gravity anomalies and deflection residuals for all stations in the United States fully justifies the assumption of compensation complete within a few tens of miles below the earth's surface and makes it appear highly probable that masses of continental or even considerably smaller size are maintained in essentially complete equilibrium. However, the Hayford-Bowie depth of compensation, arrived at by considering all known stations, can at best be only an average value. Probably the depth actually varies between wide limits; and if the average value is applied to a limited region where the depth may be considerably greater or less than the average, an error is introduced which seriously affects the geological usefulness of the computations. Furthermore, the assumption of compensation uniformly distributed in depth will introduce important errors in a consideration of particular districts, although such an assumption may be justifiable in considering a region of continental dimensions as a unit.

The Bouguer method of reduction omits the assumptions mentioned above[1], and therefore the data derived by this method are considered more valuable for special geological use than the Hayford-Bowie data. In the Bouguer anomalies we see a direct comparison between observed values of gravity and the theoretical values computed without assumption of isostasy. Thus the complete discrepancy for each station or group of stations, unaffected by further assumptions, is available for study in the light of geological conditions in the district. Viewed impartially, the two methods of reduction should not conflict or give occasion for the growth of rival schools. Each of the methods is valuable for a particular purpose. The value of the Bouguer method to the geologist is well appreciated after study of the isanomaly map for Central Europe prepared by Kossmat and Lissner (reproduced by Born, p. 73). The Alps and other young mountain systems stand in sharp relief as areas of low density, whereas the lowlands of Europe appear generally as districts of comparatively high density. A close relationship of gravity values to the larger units of topography and of geologic structure is evident at a glance, and certain apparently anomalous areas are marked out for special study. The Germans have developed a method for evaluating the degree to which the relationship is complete. By application of this method the region of the Alps is found to have a certain excess of mass, in spite of the marked deficiency in density. This fact, considered with the geologic recency of folding and thrusting in the Alps, suggests an appreciable lag in adjustment after deformation.

[1] W. D. Lambert points out (*Amer. Journ. of Sci.*, Ser. 5, Vol. 8, 1924, pp. 92-93) that the Bouguer method involves some assumption in correcting for the effect of topography about stations.

Although it is not mentioned by Born, a Bouguer map of the United States prepared under the direction of William Bowie is of interest in this connection.[2] The map is necessarily of a highly generalized character, since only some two hundred observations were available for its construction. Nevertheless certain broad relationships are evident. Except for small positive areas near the coasts practically the entire country is shown with negative Bouguer anomalies. Thus the relatively low density of the continental mass is emphasized, and there is a suggestion that present areas of heavy sedimentation have a certain degree of overload. The Appalachian axis is outlined by contours of relatively large negative anomaly, and the entire Western Cordillera, including the Colorado plateau, appears as a huge density syncline, with subordinate deeper basins. With multiplication of stations in this mountain area the relation between gravity values and geologic structure should become more striking. Additional stations in the basin ranges are particularly to be desired. At present the anomaly map of Nevada depends on only three stations, not especially representative of geologic conditions; and the entire Sierra Nevada is shown as an area of negative anomaly on the basis of a single station. More complete Bouguer isanomaly maps will be of value for geologic study.

Present State of Equilibrium in the Earth's Crust

Dr. Born analyzes at some length the available data, including Hecker's observations at sea, indicating the present state of equilibrium in the earth's crust. Except for the Indian Ocean, which shows decided excess of mass, the wide oceanic areas appear to be very completely compensated. Continental slopes show an apparent departure from the isostatic condition, owing to the disturbing influence of the steep gradient. Zones of recent orogeny in the southwestern Pacific have striking departures from equilibrium. The Tonga Plateau and Tonga Deep, which have respectively very large positive and negative anomalies, are believed to represent a young mountain mass and its foredeep. Volcanic islands and submarine volcanic masses generally have large positive anomalies, which Born ascribes in great part to overload. Such features logically have excess of mass, for they represent rapid accumulation of material without the compensating influence of erosion. In analyzing these large anomalies Born makes due allowance for the disturbing influence of steep borders. He also ascribes a part of the apparent overload to high specific gravity near the station but considers this factor subordinate, pointing out that deep water bodies, whether of large or limited lateral extent, appear to have little influence in lowering gravity values, although water is much lighter than rock. Born's position is in striking contrast to that of Bowie, who attaches large importance to the influence of heavy or light material near the station. Arguments so far presented on

[2] See William Bowie: Investigations of Gravity and Isostasy, *U. S. Coast and Geodetic Survey Special Publ. No. 40*, Washington, D. C., 1917.

both sides of the question are largely of qualitative character, although the matter appears sufficiently important to demand careful quantitative analysis.[3]

Turning to the continents, Born finds that the old Russian table-land, as well as the mosaic of Central Europe, including the Harz Mountains, have a slight but unmistakable excess of mass. The explanation suggested is an incomplete return of subcrustal material to the closely adjacent region recently relieved of its ice load. Synclines or foredeeps bordering young folded mountains generally show deficiency of mass, despite their recent load of detritus. Perhaps this deficit aids in giving regional compensation for the overload in the mountain mass. The table-land of West Africa appears to have excess of mass, but with assumption of uniform compensation to a depth of 150–200 kilometers this apparent excess tends to disappear. In the great *graben* system of East Africa the *graben* stations show decided mass deficit, whereas the intervening plateau stations show excess of mass. Born concludes with Kohlschütter that this region is almost or entirely uncompensated.

The Part of Isostasy in Orogeny

Isostasy is held to play a secondary but important part in orogeny. It is of interest to find that several German geologists are turning to a modified form of Airy's original hypothesis (1855) in an attempt to harmonize the facts of mountain folding and thrusting with the demands of isostatic compensation. A. Heim proposed in 1918 that compressive forces responsible for folded structure cause a great thickening of the crust in the mountain zone. According to this theory a mountain chain or system protrudes downward as well as upward, the downward protuberance of light material into the heavy subcrustal zone being great enough to support the mountain mass by flotation. F. Kossmat has adopted and developed the theory (1921), and Born adds his support. This conception of mountains has been championed recently in America by A. C. Lawson. Born suggests that the height of mountains is limited because below a certain depth the downward bulge will be melted and the light magma distributed. Under certain conditions such melting may occur on a considerable scale and with comparative rapidity, resulting in partial or complete submergence of mountains shortly after their development.

The conception of variable thickness in a light crust has much to commend it, and probably will grow in favor. There are no geodetic data actually opposed to the idea, and from a geologic viewpoint it appears most probable. Born discusses the subject briefly, but it invites further development and illustration. The conception as represented in Figure 1 may be compared with Bowie's illustration of perfect isostasy (Fig. 2). Copper, with a specific gravity considerably less than that of mercury, was chosen for purposes of

[3] David White has made some quantitative estimates, using tables furnished by Bowie, in "Gravity Observations from the Standpoint of the Local Geology," *Bull. Geol. Soc. of America*, Vol. 35, 1924, pp. 207–278.

the illustration because it gives a measurable difference in the upward projection of the blocks. Bowie's figure, showing blocks with different specific gravities and equal masses, illustrates the conception of uniform compensation to a constant level. The figures may be considered as representing accurately the views of Airy and Pratt respectively. No doubt both views are extreme, and the truth lies somewhere between; but for the parts of a continental mass, composed largely, as we believe, of granitic material, Airy's theory appears on the whole to be the more acceptable. Certainly

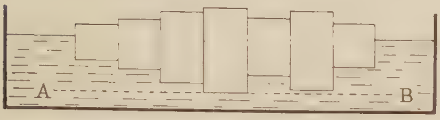

FIG. 1

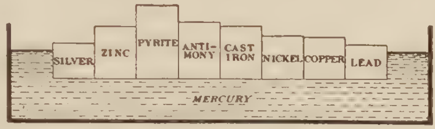

FIG. 2

FIG. 1—An illustration of isostasy, according to Airy's conception of a light crust with variable thickness. The blocks are of copper floating in mercury. Applying the conception to the earth, the line A-B represents the *isopestic* level (H. S. Washington), at which loads on equal areas are exactly the same.

FIG. 2—An illustration of isostasy, according to Pratt's conception of a crust with variable density and with uniform distribution of compensation to a constant level. (From W. Bowie, Isostatic Investigations and Data for Gravity Stations in the United States Established Since 1915, *U. S. Coast and Geodetic Survey Special Publ. No. 99*, 1924, p. 13.)

it permits the more logical explanation of mountains formed and maintained essentially in isostatic equilibrium, wherever compressive forces have been an important factor in developing the mountain structure. It is not yet clear that the theory can be applied logically to tilted blocks of the Sierra Nevada type or to broad, simple arches like the Big Horns.

Evidence from Glaciated Regions

Born considers that the behavior of the crust under extensive loading and unloading is best indicated by the history of Pleistocene ice sheets. Northern Europe and northeastern North America obviously sank under the ice load and have been reëlevated after the melting of glacial ice. That adjustment has lagged behind the unloading is indicated by the present slow but measurable rise in Fenno-Scandia, the center of the European sheet. According to Born's interpretation, adjustment under the growing ice cap occurred by means of a slow subcrustal flow, with broad upwarping in bordering unglaciated regions. The return movement following unloading has not been of a simple nature but has occurred in a series of waves with a somewhat complex record. If this readjustment is actually incomplete, then gravity measurements should indicate some deficiency of mass in central Fenno-Scandia and a slight overload in neighboring regions. These expectations are fully sustained. With a few exceptions readily explained by local geological conditions, the stations for central Fenno-Scandia show decided negative anomalies. Nearly normal gravity is indicated in the outer glaciated zone, whereas central Germany and the Russian platform have small

but unmistakable excess of mass. Gravimetric data for northeastern North America are less complete. The isobase map for this region given by Born is obviously inaccurate.

Erosion and Sedimentation in Relation to Isostasy

The book includes a valuable discussion of erosion and sedimentation in relation to isostatic adjustment and cites many suggestive geologic illustrations. The area of sedimentation is ordinarily smaller than the areas contributing to the detritus and therefore may be expected to suffer earlier and more frequent movements, provided purely isostatic conditions control. Adjustment occurs in a series of spasmodic depressions and elevations, with intervening periods of quiet. Sinking in the loaded area may or may not coincide with uplift in the area suffering erosion. As a case of closely connected movements Born cites the erosion surfaces and coastal plain formations of the eastern United States, particularly as discussed by F. Bascom.[4] Another suggestive illustration is found in the French-English Eocene, which exhibits a rhythmic alternation of marine and continental sediments. Areas of sedimentation strictly under isostatic control should have either normal gravity or some excess, whereas corresponding areas of erosion should vary between normal gravity and some degree of deficiency. As a matter of fact many eroded districts show positive anomalies, and some areas of heavy sedimentation have negative values, indicating that important factors other than the isostatic are to be considered.

Born emphasizes the point that sediments in deltas or geosynclines have appreciably smaller density than material displaced isostatically at depth, and therefore very thick accumulations in shallow water necessarily require for their formation forces other than those concerned in isostatic adjustment. It may be noted that this point, readily admitted and frequently discussed, has recently been entirely neglected in practice by certain writers in this country who appear to consider that an area once submerged may be pushed to an indefinite depth by the weight of sediments alone. The principles of isostasy are being invoked to perform feats that are mechanically impossible.

Two outstanding problems are mentioned for consideration by students of isostasy. (1) How shall we explain, in accordance with the requirements of isostatic theory, the elevation of broad areas from sea level or lower into plateaus such as the Colorado plateau? (2) What explanation is to be offered for a feature such as the Ferghana basin in Turkestan, which has been a subsiding area, receiving thick sediments, from the Lower Cretaceous to the present and yet shows uniformly large negative gravity anomalies? Such problems call for serious study.

Born quotes Barrell freely and agrees with him that present evidence indicates regional and not local compensation. He considers, however,

[4] Florence Bascom: Cycles of Erosion in the Piedmont Province of Pennsylvania, *Journ. of Geol.*, Vol. 29, 1921, pp. 540–559.

that Barrell's argument from a study of deltas is inconclusive. Probably there is no standard minimum size for compensated areas, because the strength of the crust appears to vary widely in different parts.

It has often been stated, and by no one more emphatically than by Dr. Bowie in this country, that isostasy is a problem for geologists. Books such as Dr. Born's indicate that geologists appreciate the truth of the statement and that structural geology in particular is finding in the theory of isostasy a valuable aid rather than an added obstacle.

AMERICAN GEOGRAPHICAL SOCIETY

Meetings of November and December. The first regular monthly meeting of the American Geographical Society for the season of 1924–1925 was held on November 25, at the Engineering Societies' Building, 29 West Thirty-ninth Street. After a word of welcome to the Fellows of the Society on the part of President Greenough, the meeting was addressed by Count Byron Khun de Prorok on "Ancient Carthage and the Dead Cities of the Sahara." A special aspect of Count de Prorok's work in northern Africa will be described by him in an article "Ancient Trade Routes of the Carthaginians and Romans Across the Sahara" to appear in a forthcoming number of the *Geographical Review.*

Dr. Lauge Koch, the lecturer at the December meeting of the Society, has entitled his address "Explorations in Northernmost Greenland." It deals with his three expeditions to northern Greenland. An account of some of the scientific results of the expeditions will be published in a forthcoming number of the *Review.*

Elections to Fellowship. At the November meeting of the Society, President Greenough presiding, there were presented with the approval of the Council the names of 197 candidates who were duly elected as Fellows of the Society.

Election to Corresponding Membership. At its meeting of December 23 the Society elected to Corresponding Membership Dr. Lauge Koch and Count Byron Kuhn de Prorok. Dr. Koch has explored and mapped about a fourth of the coast line of Greenland and his results will be published in a series of maps by the Danish government. His first field work in Greenland was made on one of the Danish scientific foundations, and its purpose was the study of the glacial features of West Greenland. Next he was a member of Rasmussen's Second Thule Expedition and still later (1920–1923) conducted the Danish Jubilee Expedition (see "Plan of the Bicentenary Expedition to the North of Greenland," *Geogr. Rev.*, Vol. 10, 1920, pp. 348–349), which rounded out his studies over a great area. For his work he has been honored both at home and abroad, and his decorations include the Danish gold Medal of Merit awarded in 1923.

Count de Prorok has been engaged for the past three years in excavating the ruins of Carthage under the auspices of the French government and with most interesting results, which include the discovery of ruins now under the sea traced by the aid of aerial photography. The successive cultural layers and sites of this famous city have never been adequately studied, and an attempt is now being made to execute a ten-year program with the coöperation of a number of American and French institutions.

Award of the Charles P. Daly Medal to Knud Rasmussen. Knud Rasmussen, the Danish explorer, has been awarded the Charles P. Daly Gold Medal of the Society for 1924 for his explorations in Greenland and northern North America. For twenty-five years he has studied the life of the Eskimo and explored northern lands. An account of his work and that of his assistants on the Second Thule Expedition has appeared in the *Geographical Review* (Vol. 8, 1919, pp. 116–125, 180–187). His latest expedition—the so-called Fifth Thule Expedition—occupied three years, and the field of his work included the whole stretch of territory between Greenland, and Siberia as well as the study of the folklore, language, present distribution, migrations, and particularly the foci of migrations of all the known Eskimo tribes and families. The results will be issued in a series of volumes and

maps the character of which may be forecast from the excellence of his previous books, among which the most noteworthy are "Greenland by the Polar Sea," "Eskimo Folk Tales," and "The People of the Polar North."

Presentation of the Cullum Geographical Medal to Jovan Cvijić. The presentation of the Cullum Geographical Medal to Dr. Jovan Cvijić (see *Geogr. Rev.*, Vol. 14, 1924, p. 466) took place at Belgrade on August 23 last. The ceremony was held at the United States Legation and was attended by a distinguished gathering from governmental and university circles.

The proceedings opened with a speech (in French) by the American minister, Mr. H. Percival Dodge, pointing out the significance of the ceremony: "It is the first time, unless I am mistaken, that a high American scientific distinction has been conferred upon a high scientific personality of the Kingdom of the Serbs, Croats, and Slovenes." After enumerating the bonds between the two countries Mr. Dodge continued:

"Thus our cultural relations of people to people are happily constantly increasing, and your men of science as well as their splendid works are becoming more and more known and appreciated in my country.

"Among these no one is better known or more appreciated than Professor Jovan Cvijić, who is the author of works of exceptional importance in geographical science and especially in connection with the geography of limestone regions. These works enjoy the highest reputation among the scientific authorities of my country, as well as the fine publications of Professor Cvijić on the ethnography and cultural history of the Balkan peoples. That is why our oldest and best-known geographical society, the American Geographical Society of New York, has desired to give Professor Cvijić a proof of its esteem and appreciation, proof in which, I may assure you, all American scientific societies associate themselves. For this purpose this Society has now sent to your eminent compatriot its highest distinction, the Cullum Geographical Medal.

"This medal, founded by a General of the American army, George W. Cullum, a distinguished geographer, who was from 1877 until his death in 1892 Vice President of the American Geographical Society, is, according to the directions of its founder, to be given from time to time to those who have distinguished themselves in geographical discoveries or in the advancement of geographical science. Since its foundation this medal has only been given to twenty-three persons, of whom I may mention Admiral Peary of the American Navy, the discoverer of the North Pole, Dr. Fridtjof Nansen, the Duke of the Abruzzi, Sir Ernest Shackleton, Dr. Charcot, Colonel Goethals of the American Army, the builder of the Panama Canal, M. de Margerie, the celebrated French geographer, and the late Prince of Monaco. As you will see from this list Professor Cvijić has illustrious predecessors. He will be their very worthy associate."

Mr. Dodge thereon handed the medal to Dr. Cvijić who, in accepting it, said:

"Although very much absorbed by my personal researches I have nevertheless familiarized myself with the results and leading ideas of American students of the science of the earth, especially terrestrial morphology, wherefrom I have received most helpful suggestions. Especially have I learned to appreciate the originality and vigor of the American mind.

"Accordingly I am all the more honored by receiving from the Geographical Society of New York the high scientific distinction which this Society has been kind enough to bestow upon me."

Following Dr. Cvijić's response speeches were made by Dr. Korochetz, Minister of Public Instruction, and Dr. Bogdan Gavrilovitch, Rector of the University of Belgrade, tendering thanks for the recognition of their country and university in the award to Dr. Cvijić.

Mr. Platt's South American Mission. In September last Mr. Raye R. Platt, who is in charge of the Millionth Map of Hispanic America in preparation by the Society, sailed for South America. He represented the Society at the meeting of the Third Pan American Scientific Congress at Lima on December 20. He is visiting various societies and government bureaus and other centers of research. There will also be afforded an opportunity to do a modest amount of field work. Mr. Platt expects to return in March, 1925.

Distribution of Title Page, Contents, and Index of Vol. 14 of the Geographical Review and of the Special Supplement "The Application of Acoustics to Submarine Surveying." The title page, table of contents, and index for Volume 14 of the *Geographical Review* (1924), which is issued separately, is ready for distribution. Copies are sent to all institutions exchanging publications with the Society and to individuals who request that their names be put on a list for this purpose. The special supplement to the October number of the *Geographical Review* may be obtained similarly. This is a paper by Harvey C. Hayes, Research Physicist to the United States Navy, entitled "The Application of Acoustics to Submarine Surveying."

Recent Publications

The Geographical Lore of the Time of the Crusades: A Study in the History of Medieval Science and Tradition in Western Europe. The Society announces the publication of *Research Series No. 15*, by John Kirtland Wright, librarian of the Society. The volume illustrates the geographical ideas that prevailed at a time when medieval civilization had attained to its highest and perhaps most typical development. The period covered is the twelfth and early thirteenth centuries, roughly the age of the Crusades (1097–1270 A. D.) and of the building of cathedrals, a time when Western Europe was stirring with vital enterprise and creative force.

The term "geographical lore" has advisedly been chosen instead of "geography" or "geographical science" because its meaning is much broader. As exemplified by the topics discussed in this volume, "geographical lore" embraces the naïve and often picturesque misinformation which was fully as characteristic of the age as the more accurate knowledge that it possessed. On the other hand, it embraces the results of precise observation and shrewd reasoning, which, contrary to the misapprehensions of many, were not at all lacking in the Middle Ages. Dr. Wright's book is thus a study in the history of science as well as in the history of tradition and legend.

The authority of the written word was held in high esteem during the Middle Ages. Much of the geographical lore of the time of the Crusades consisted of beliefs and prejudices derived from the writers of antiquity, from the Bible, from the Church Fathers, and from Moslem scholars of Spain and the Orient. The first three chapters, therefore, deal with the contributions of these earlier authorities to medieval geography. Chapters IV and V treat of those books and maps of the period that are of geographical interest and of the place of geography in the medieval scheme of learning. Then follow eight chapters on the actual substance and character of the geographical lore of the time of the Crusades. Here are discussed, among other matters, doctrines of the Creation: remarkable developments out of the cosmogony of the Book of Genesis; theories regarding the shape of the earth and whether or not it is immobile; speculations on the antipodes and their fabulous inhabitants, belief in the existence of whom was held to be heresy of the worst order; ideas of the atmosphere, of the waters above and below the firmament, of mountains, volcanoes, and islands; of astronomical geography; and finally what was known and imagined concerning the countries and peoples of the known world. The book contains twelve illustrations, consisting of diagrams and reproductions of twelfth- and thirteenth-century maps.

Early Topographical Maps. The publication is announced of "Early Topographical Maps: Their Geographical and Historical Value as Illustrated by the Harrison Collection of the American Geographical Society," *Library Series No. 3*, by John Kirtland Wright, librarian of the Society. This forms the third of a series of pamphlets dealing with the collections of the Society, the first two being Dr. E. L. Stevenson's "Maps Reproduced as Glass Transparencies, Selected to Represent the Development of Map-Making From the First to the Seventeenth Century," 1913, and "A Description of Early Maps, Originals and Facsimiles (1452–1611), Being a Part of the Permanent Wall Exhibition of the American Geographical Society," 1921.

The maps of the Harrison collection date from the eighteenth and early nineteenth centuries, the period when topographical cartography was first developed along scientific lines. The twofold interest of such maps was pointed out in an article in the *Review* for July, 1924, pp. 426–432. Since the publication of this article Mr. Harrison has presented the Society with a set of the famous Cassini map of France dating from the latter half of the eighteenth century (scale 1:86,400; 179 sheets). Maps of this sort not only provide the historian and geographer with a means of tracing during the last two hundred years the evolution of various elements in the human geography of western and central Europe, but they afford a graphic representation of the intellectual character of their age by depicting the development of the many-sided art of cartography. In Dr. Wright's pamphlet the points briefly discussed in the article in the *Review* are developed, most of the maps are listed, and many of the more important ones commented upon in detail. The booklet should be of value to military historians interested in the continental wars of the eighteenth century and the Napoleonic era because it provides an introduction to documents of no little importance as original sources for studies in this field.

GEOGRAPHICAL RECORD

NORTH AMERICA

Canada's Most Northerly Outposts of Civilization. The most northerly outpost of civilization in Canada, Craig Harbor, Ellesmere Island, little more than 800 geographical miles from the North Pole (latitude 76° 10′ N.), comprises a police post,

FIG. 1—Map of the North West Territories of Canada redrawn (scale approximately 1:30,000,000) from the map (scale 100 miles to 1 inch) accompanying J. D. Craig's report. Hunting and trapping areas reserved for native Indians, Eskimos, and Halfbreeds are shaded in dashes. The localities where official stations have been established in Franklin District are also shown.

customhouse, and post office. This station was erected in 1922 by an expedition under the North West Territories Branch of the Department of the Interior, on which voyage a second post also was established farther south at Ponds Inlet, Bylot Island (J. D. Craig: Canada's Arctic Islands: Log of Canadian Expedition 1922, Dept. of the Interior, North West Territories and Yukon Branch, Ottawa, 1923). The event marks the initiation of a policy of official surveillance in Franklin District, the archipelago of Arctic Canada. Counting islands over 500 square miles in area and not including discoveries by the Canadian Arctic Expedition of 1913–1918, the land area of this region is estimated at over 500,000 square miles, rather more than the combined areas of Alberta and Saskatchewan. The Reindeer and Musk-ox Commission of 1920 urged the necessity of taking immediate steps for the protection of

the natives and the big game. Trading companies, British and foreign, are establishing posts and sending expeditions into the region. Murder cases among the Eskimo indicate the desirability of police supervision. It is furthermore hoped to use the official stations as bases for scientific survey, especially of mineral resources.

The Craig Harbor post is established in a low flat valley surrounded by limestone-capped granite hills 1800 to 2000 feet in height. A glacier descends to within two and one-half miles of the shore: at one time it evidently discharged into the sea, and retreat is apparently still in progress. No animal life was seen on shore, but waterfowl, bears, seals, and walrus are abundant. A plane-table and photographic survey of the valley was made. At Ponds Inlet, where there is also a Hudson's Bay Company post, time was more limited, and mapping was restricted to a phototopographic survey and some triangulation in the immediate vicinity of the station. Throughout the voyage time received by wireless enabled the checking of existing charts, many serious errors being corrected. The Air Board observer who accompanied the expedition reports the existence of many localities suitable for airdromes and landing places and recommends the establishment of an air experiment station. From the latter part of May to early August conditions for aviation are generally favorable.

Conditions experienced during the winter of 1922–1923 by the detachment on Ellesmere Island are described in the annual report of the Royal Canadian Mounted Police. "Severe blizzards were frequent and during January the wind blew for 21 days without a break, at times with the violence of a gale; a comprehensive idea of the winds of this region can be gained from the fact that during a period of 304 days the wind blew strongly for 221 days, frequently compelling the men to remain indoors for days at a time. The coldest temperature recorded was 51 degrees below zero in March, during which month the temperature averaged 35 degrees below, the coldest month of the year."

It had been hoped to move the detachment to Cape Sabine, on the east coast of Ellesmere Island about 200 miles farther north, but ice conditions rendered this impossible. A new post, however, was established at Pangnirtung Fiord in Cumberland Gulf, Baffin Island.

The November issue of *Natural Resources, Canada,* of the Department of the Interior, reports that the projected station in the Kane Basin region was successfully installed in 1924, in latitude 78°46′N., "about 2,300 miles due north of Ottawa."

The Future of the United States as a Wheat Exporter. In the conclusion to his excellent little book "Le blé dans le monde" (1923) René Musset, following Leroy Beaulieu (1913), takes a rather pessimistic view of the future of the world's wheat supply, though finding some satisfaction in the fact that France is nearly self-supporting.

M. Musset points out that consumption tends to overtake production. Before the war western Europe consumed about one-third of the world's wheat while producing only one-sixth. This production cannot be substantially increased—a view, however, in which J. Beauverie, who summarizes and analyzes M. Musset's work in the *Revue Générale des Sciences* (Vol. 35, 1924, pp. 454–462, 493–505), does not concur, believing that insufficient allowance is made for improvements in cultivation and marketing. As regards exporting countries the future of the greatest of them, Russia, is a matter of conjecture: rehabilitation will at best be a long process. Reliance cannot be placed on India and Australia because of the droughts to which they are subject. In 1919 all export of grain from India was prohibited. Permanent prohibition of export of food grains has indeed been advocated though rejected by the economists (Gilbert Slater: Famine and Export, *Indian Journ.*

of Economics, Vol. 3, Allahabad, 1920–1922, pp. 516–521). Australia, furthermore, has a growing consumption, as have the other great wheat-exporting countries—Argentina, Canada, and the United States. In Argentina and Canada vast areas await cultivation, but the best lands have already been occupied. The United States is changing from an agricultural to an industrial nation, and its production from the "export crop" type to the "supply" type. Dr. Newbigin, in her new "Commercial Geography" (Home Univ. Library No. 105, 1924), takes the United States as the example of a "transitional community" (see also the chapter on cereals).

When Russia ceased to figure in the international wheat trade the lead was taken by the United States. In 1922–1923, however, Canada assumed first rank and increased the lead still further the next season. Acreage under wheat in the United States, which was increased by 16 per cent during the war, has declined since 1919. M. Musset points out that the enormous harvests of 1915 and 1918 are likely to represent the maximum. In Canada acreage was increased 129 per cent during the war, and it has increased notably in the three years 1920–1923. The significance of these trends is discussed by Mr. Theodore D. Hammatt of the U. S. Department of Commerce in an article in *Foreign Affairs*, "Can America Export Wheat?" (Vol. 3, 1924, pp. 124–134). It is not merely a question of increasing population and increasing consumption but one of economical production. In the United States the land best suited to wheat has been taken up. The wheat farmer is already subjected to much more severe competition than the producer of corn or cotton. The western wheat farmer is now encountering competition similar to that which he imposed on the eastern farmer of forty years ago (International Competition in the Production of Wheat for Export, *Suppl. to Commerce Repts.*, *Trade Information Bull. No. 210*, Washington, D. C., 1924). We have already indicated Canada as the chief competitor.

In Canada production costs—land and labor—are lower. Canadian wheat is of excellent quality whereas the United States wheat exported is mediocre, the best being retained for home consumption. Seventy per cent of the Canadian crop is exported, and organization is naturally devoted to this end. Winnipeg is the largest primary wheat market of the world. The serious transportation problem is well met. "Fort William-Port Arthur contains the largest and finest elevator equipment of any port in the world. The 25 terminal elevators there have a storage capacity of 62,690,000 bushels and are equipped to load 7,750,000 bushels aboard ship in a 10-hour day. During the busy season from September 15 to December 15, grain moves through Winnipeg to the lake front at the rate of from 1000 to 2500 cars a day. At times, trains of cars loaded with wheat leave Winnipeg at 20-minute intervals." (For details see T. D. Hammatt: Marketing Canadian Wheat, *Suppl. to Commerce Repts.*, *Trade Information Bull. 251*, Washington, D. C., 1924.)

Human Influence on the Habitability of the Pueblo Country. Decline in the population of the Pueblo country of the southwestern United States has been ascribed to climatic change whereby the country has been rendered less habitable for agricultural settlement. That man himself has been an important agent in the physical changes of the region is the view advanced by Albert B. Reagan in a note in *Science* (Recent Changes in the Plateau Region, *Science*, No. 1552, Vol. 60, 1924, Sept. 26, pp. 283–285).

Until very recently the streams in the region were aggrading their valleys where now the opposite phase is in progress. A few decades ago, for instance, Laguna Creek was nonexistent: the valley and canyon floors were a vast plain dotted with lakes and swamps. Now the region has been drained and cut up into a maze of straight-walled chasms, fifty feet or more in depth. The aggrading phase has been explained as the consequence of wind action and little rain. Mr. Reagan suggests

that it might equally well be due to the labors of a large agricultural population of earlier days. Then "each little wash and flat had its village, and the water was carefully husbanded in the irrigation of the necessary fields and was impounded by reservoirs and check dams for village use." Thus run-off was reduced to a minimum and the degrading power of the streams curtailed. Eventually the agriculturists abandoned the region—Mr. Reagan does not give a hint as to the cause—but the established condition remained until equilibrium was disturbed by the arrival of the Navajo with his stock and the white man with his roads and trails. Now over ninety per cent of the flood water escapes, and rapid cutting is in progress.

The Political Status of the Isle of Pines, Caribbean Sea. "The Isle of Pines Controversy," an article by Captain Elbridge Colby appearing in the October, 1924, number of the *Bulletin of the Pan American Union* calls attention to the anomalous political status of the large island off southwestern Cuba. The Isle of Pines occupies rather less than 1000 square miles and at the nearest point is 35 miles from the Cuban mainland. In Spanish times it was administered as an integral part of Cuba. Regarding the matter of ownership Captain Colby quotes an interesting reference from William E. Hall, the English authority on international law, who, in the 1895 edition of his standard treatise, "selected the Isle of Pines as an example of outlying islands enclosing a salt water lake and to be considered as a part of the land it adjoins." By the Treaty of Cuba, March 2, 1904, the United States relinquished in favor of the republic of Cuba "all claim of title" to the Isle of Pines. The Platt Amendment of July 2, 1904, further provided that the Isle of Pines "shall be omitted from the proposed constitutional boundaries of Cuba, the title thereto being left to future adjustment by treaty. The treaty has never been ratified. Since 1902 the island has been under the *de facto* government of Cuba.

Prior to the Spanish War American interest in the Isle of Pines was directed towards its strategic possibilities. The island commands the southern entrance into the Gulf of Mexico, as Key West commands the northern approach. When attention became focused on the Panama Canal project strategic considerations were extended from the Gulf of Mexico to the Caribbean as a whole, and interest in the Isle of Pines waned. The mineral resources of the island appear to be of no great significance, and lumbering possibilities are limited. Its chief importance lies in agriculture. In 1899 only one per cent of the surface was cultivated (*59th Congr., 1st Sess., Senate Doc. No. 311*, 1906). The southern region is inaccessible and remains little known. North of the great central swamp a considerable area of land has since been cleared and with particular success devoted to citrus crops, in large part by American capital.

The population, which numbered 3000 at the census of 1899, is now about 5000, of whom 800 are Americans. Americans own about 90 per cent of the property.

SOUTH AMERICA

Features of the Agrarian System in Peru. Among the economic problems having a geographic basis that confront the countries of Latin America, one of the most fundamental is that of land tenure. Colonization of those regions by sixteenth-century Spain and Portugal transplanted to America the semifeudal agrarian system which still survived at that time in southern Europe, while in several sections of the New World, particularly in the highlands where an agricultural population had evolved its own social institutions, methods of landownership were decidedly influenced by those pre-Columbian institutions. Furthermore, relative isolation during several centuries permitted the survival of antiquated features. Now that contact with the outside world is closer, interest centers about the need of reforms that will bring the system into closer harmony with present-day conditions. Illustrative

of this interest are a number of recent discussions concerning the agrarian situation in Peru.

The typical features of land tenure characteristic of Latin America in general, particularly of the countries with a strong Indian element in their population, are found in Peru, and great diversity of geographic conditions makes the situation there also representative of that existing in widely separated regions of the continent. Each of the great natural divisions of the country is characterized by distinctive methods of landholding and, consequently, by a different relation of the tillers of the soil to the lands they occupy—this, in spite of the fact that legislation has repeatedly attempted to bring about uniformity (see César Antonio Ugarte: The Agrarian Policy of Perú: Notes for an Economic History of the Republic, *Inter-America*, Vol 7, 1923, pp. 35–45 (with bibliography); translated from the *Mercurio Peruano*, Lima, Peru, May, 1923).

In the Sierra where a scant precipitation and well-marked seasons had forced the aborigines to depend upon cultivation of the soil and where summer rains, an abundant water supply, and limited areas of fertile soil had made such dependence possible and where, as a consequence, an agricultural Indian population had dwelt long before the European invasion, most of the land is now held in a dual form of tenure. The great estates created by the Spaniards and still owned by families of European or mixed blood contain numerous Indian tenants who also possess certain well-defined rights to the lands which they and their ancestors have used for many generations. So closely bound to the soil are these Indian tenants that they usually remain upon the estate even in case of a change of super-owners, and the value of a farm is frequently reckoned by the number of Indian laborers it contains rather than by its acreage. In addition to the dual system of tenure, however, there exists a primitive communal system found particularly in the more isolated districts of the plateau region of Colombia, Ecuador, and Bolivia as well as in similar districts in Peru. Throughout the history of these Andean lands (pre-Inca, Inca, and Spanish) this system has prevailed, suffering modification but stubbornly persisting to the present time (see Carlos Valdez de la Torre: Evolución de las comunidades de indígenas, Lima, 1921). In these Indian communities, though the original bond was probably consanguinity, such relationship was very largely destroyed by the conquest and colonial organization of Inca and Spaniard in turn, in each of which there resulted a considerable shifting of population. At the present time many of these communities are purely agrarian in character, a collective tenure of the land and a common interest in its use serving as the bond of union.

In the narrow irrigated valleys that constitute the only arable lands in the coastal desert the system of land tenure is more modern. The aboriginal population has almost completely disappeared and with it both the primitive form of holding the land and the dual method brought by the conquerors. The land is held in a simple allodial tenure, in properties usually smaller than those of the plateau, since the land is capable of more intensive development, but still large enough to be styled plantations. This region with its crops of sugar cane, cotton, and rice has repeatedly suffered from a lack of farm laborers and has resorted to the importation of foreign elements—in early years negro slaves and later Chinese, Japanese, and Germans. But these foreign laborers have served merely as hired "hands;" none of them have been sufficiently permanent to affect the system of land tenure. They have either risen into the ranks of proprietors themselves or have gone into other lines of activity. The coastal region continues to have as its characteristic agrarian unit the plantation with free hired labor.

In the *montaña*, the forested region east of the Andes, still different agrarian conditions are found. The little land that has been occupied for agriculture has usually been developed under typically pioneer conditions. Here the forests have been cleared and kept cleared, the virgin soil broken, and a completely new country set-

tled—with only the untamed Indians of the forests to supplement the labor of the colonists themselves. Repeated efforts have been made to induce colonists, either foreign or national, into this region, but so far with but little success. German and Irish settlements have been attempted, but distance from markets and difficult communication have combined, with the effects of the tropical climate, to render such attempts abortive.

GEORGE M. MCBRIDE

An Explanation of Certain Ancient Mounds in Northwestern Argentina. An interesting explanation of certain curious mounds in the Lerma Valley of northwestern Argentina is advanced by Eric von Rosen in *Ymer* (Vol. 44, 1924, pp. 181–191). The mounds are at a place called Pucará (= fortress) a few miles north of Rosario de Lerma. They are circular, barely a half meter high, 2.6–2.7 meters in diameter, and surrounded with a single or double ring of stones. One group includes over a thousand mounds arranged symmetrically in rows. Nearby are ancient dwelling sites. Excavation proves that the mounds were not used for burial purposes. In Boman's opinion (Antiquités de la Région Andine) they were for ceremonial usage. From their resemblance to certain mounds in central Africa it is, however, suggested that they may have been used in agriculture. The African mounds, good examples of which occur at Boroma in northern Rhodesia, are planted with manioc. They are constructed on hard flat surfaces flooded by heavy rains which fall at the planting season and tend to wash out the seeds and young plants. Rainfall conditions at the Pucará of Lerma closely parallel those of Boroma: the region also is flat and readily flooded. The method of cultivation is still known in the West Indies, and similar mounds have been described from San Domingo.

AFRICA

The Mineral Resources of French North Africa. The metalliferous deposits of northern Africa, known and exploited by Carthaginians and Romans, were almost completely neglected by the Arabs so that French conquest found in this respect almost a virgin field (J. Levainville: Ressources minérales de l'Afrique du Nord, *Ann. de Géogr.*, Vol. 33, 1924, pp. 151–166).

The region is deficient in fuels. With the possible exception of the Rif, the geological exploration of which has scarcely begun, it can be definitely said that coal resources are insignificant. Numerous indications of petroleum have raised hopes. So far none has been filled, but it must be acknowledged that investigation is far from complete. Zinc and lead ores are of numerous occurrence, but the total tonnage is not important; the largest deposits are in Tunisia. Other metallic minerals, iron excepted, are unimportant.

The great mineral wealth of the region lies in its iron ore and phosphates. Reserves of the former are now placed at 400,000,000 tons, double the figure given in the estimates of the Geological Congress in 1910. The ore is found in a band stretching from east to west, reaching the coast in Oran and at Melilla and 250 kilometers inland in Tunisia. Before the war Tunisia shipped 500,000 tons, Algeria 1,350,000 tons, Morocco 300,000 tons. Pre-war conditions have now been restored, and rapid development is in prospect. When the deposits of Wenza (Constantine) are put on the market the export will be doubled and will be trebled when the projected railway program is completed. The north African ore is of high grade, suitable for manufacture of fine steel. It is of interest to note that in 1923 important shipments were made to Danzig where, in virtue of its quality and the favorable exchange, it competed successfully with the Swedish ore.

The phosphates are still more important. A band of phosphatic chalk runs with extraordinary continuity from the Red Sea to the Atlantic. The quality of

the deposit varies considerably, but where it is not rich enough for exploitation it contributes to the richness of the agricultural lands. In 1922 2,000,000 tons were shipped from Tunisia, 500,000 from Algeria, 83,000 from Morocco. The reserves are estimated at not less than 5,000,000 tons. Thus as regards this commodity France is the second power in the world, ranking after the United States, the deposits of which are in general of higher phosphate content.

A Glacial Lake in the High Atlas. A lake in the Atlas is no ordinary phenomenon. In the Middle Atlas, it is true, there are a number of small, high-perched lakes sufficiently characteristic to have received a special designation, *aguelman*. They occur in volcanic and karstic terrains, occupying craters or poljes. In the arid High Atlas, where erosion of a torrential nature is in full swing, the lake of Ifni is unique. The lake lies at the head of a torrent tributary to the Wad Tifnut, an upper branch of Wad Sus. Jean Célérier and Albert Charton bring forward evidence indicative of a glacial origin for the lake (*Hespéris*, Vol. 3, 1923, pp. 501–513).

In 1922 the authors had already expressed their views that while glaciers no longer exist in the High Atlas these mountains had suffered earlier glaciation (Sur la présence de formes glaciaires dans le Haut-Atlas de Marrakech, *Hespéris*, Vol. 2, 1923, pp. 373–384), an opinion shared by Louis Gentil (Sur les vestiges de glaciation quaternaire dans le région de Telouet (Haut Atlas marocain), *Comptes Rendus de l'Acad. des Sci.* [*de Paris*], Vol. 178, 1924, Jan. 2, pp. 31–35). MM. Célérier and Charton confirmed their hypothesis in a journey in 1923 whereon they found "glacial phenomena of which the extent and clearness is surprising."

The lake of Ifni occupies the bottom of a cirque whose walls rise 1500 to 1800 feet. The mouth of the cirque is closed by a natural dam. Below lies a broad valley, fresh and green, a delightful oasis supporting five villages in its five kilometers of length. There are meadows on the valley floor, cultivation on terraces, and a group of enormous century-old walnut trees at the head of the valley. The oasis terminates downstream in a narrow gorge cut through a rock bar (M. André Allix suggests this term as the equivalent of the French *verrou*). Upstream the barrage marks the limit of trees and cultivation. The bare rock mass rises like a giant staircase 500 meters above the level of the valley. Its length is estimated at some three kilometers. The highest point, in the center, is 2555 meters above sea level. Deep furrows separate the mass from the mountain flanks. The material composing the barrage is not homogeneous—at least three different rock groups are represented—and the size of the fragments varies greatly; there are some enormous blocks, weighing hundreds of tons, all angular and freshly fractured, and an enormous amount of finer material, gravels and broken stone, the finer material predominating in the lower part of the mass and on the downstream slope. The barrage rises 160 meters above the lake, which has no visible outlet. It is 500 meters long and about half as wide; the depth is unknown but is believed to be considerable.

The contour of the lake itself, the cirque, the valley form, the disposition and contents of the barrage point to glaciation as the cause of the lake. The only alternative explanation ascribes the barrage to a rock flow. Rock flows are characteristic of the High Atlas and are certainly a contributing factor in this particular instance, but they are considered subsequent to and independent of the formation of barrage and lake.

Steppes and Deserts; the Desert Vegetation of Tunisia. Writing on the desert vegetation of Tunisia in *Die Naturwissenschaften* (Vol. 42, 1924, pp. 861–868), Eduard Rübel takes occasion to point out different usages of the terms *steppe*, *Wüste*, and *desert*. The word *steppe* in Russian was originally applied only to uncultivated land. As taken over into the languages of western Europe it has been

used to designate almost any open, unforested region, whether grass- or shrub-covered. The German term *Wüste* is customarily applied to tracts where less than half the area is covered with vegetation, and *steppe* to regions where more than half is so covered. Rübel points out that the English "desert" is more inclusive, taking in what the Germans style *Strauchsteppe* (shrub steppe). The latter, we may add, would seem to correspond to the *desert shrub-desert grass* and *desert shrub* zones of H. L. Shantz (The Vegetation and Soils of Africa, *Amer. Geogr. Soc. Research Ser. No. 13*, New York, 1923, pp. 11 and 76–78).

In Tunisia, though there is heavy rainfall in the northwestern mountains (150 cm. = 59 in.), the greater part of the country receives a mean annual precipitation of less than 50 cm. (19.7 in.), and in the latitude of Gabes and the Shott el-Jerid the precipitation falls below 20 cm. (7.9 in.). Rübel distinguishes three main types of vegetation: that of the halfa steppe, of the wormwood steppe (*Wermutsteppe*), and of the steppe desert (*Steppenwüste*).

The halfa steppe, which lies predominantly in a belt of precipitation of between 40 cm. (15.7 in.) and 20 cm. (7.9 in.), is characterized by coarse halfa grass (*Stipa tenacissima*). This, however, because of the perennial character of its leaves should be regarded ecologically as a shrub, and the halfa steppe, hence, should be classified as a shrub steppe (*Strauchsteppe*). Halfa grass has many economic uses: the natives employ it in making ropes, baskets, and mats for the floors of mosques, and it is exported for the manufacture of paper.

The wormwood steppe, in which *Artemisia herba-alba* is the principal shrub, corresponds essentially to the plains of sage brush (*Artemisia tridentata*) of the western United States.

The steppe desert occurs in regions of less than 20 cm. (7.9 in.) rainfall. It is genuine desert according to Rübel's definition, because less than half of the surface is covered with vegetation. In the gravelly desert about Metlaui, where the winds have blown away most of the sand and finer material, the vegetation is exceptionally sparse. On the other hand where sand is more abundant and where, consequently, the ground possesses greater power of retaining water—as between Tozeur and Nefta—the growth is somewhat richer. Around the edges of the dry salt lake, Shott el-Jerid, a bush, *Limoniastrum guyonianum*, establishes itself as a sort of "pioneer vegetation." Buried by the sand and reburied as it pushes upward into the free air, this bush builds up sand hills of about a meter in height.

Rübel points out that in the regions which he defines as steppes, the presence of water tends to carry more northerly types of vegetation, like the Mediterranean olive, well to the south. In the steppe desert, on the other hand, oases of date palms are found where there is water.

Across the Libyan Desert through Kufara. Following up the dramatic journey to Kufara made in 1920–1921 with Mrs. Rosita Forbes (*Geogr. Rev.*, Vol. 12, 1922, pp. 137–138) Hassanein Bey has succeeded in carrying out a carefully planned scientific expedition across the Libyan desert to Darfur. He left Sollum on the western boundary of Egypt on December 21, 1922, and reached railhead at El Obeid, Anglo-Egyptian Sudan, July 15, 1923, a distance of 3345 kilometers. He gives the narrative of the journey in a finely illustrated article in the October and November numbers (1924) of the *Geographical Journal.* In the latter number John Ball, Director of Desert Surveys, Egypt, who has worked up the cartographical material, discusses this and other contributions to our knowledge of the Libyan Desert, and W. F. Hume, Director of the Geological Survey of Egypt, follows with some conclusions on the geological data, notes on which have been prepared by F. W. Moon. Some idea of the valuable cartographical results may be gained from the fact that Hassanein Bey's admirably executed survey was carried for over 2000 kilometers between known points. Dr. Ball remarks that the journey, "most of it

through inhospitable deserts sparsely inhabited by fanatical and predatory tribes, is one which, without a strong military escort, could have been undertaken only by a Moslem, and by one of remarkable grit, tact, and perseverance."

The narrative of the first portion of the journey—through Siwa, Jaghbub, Jalo, to Kufara via the Zieghen wells—is noteworthy for the graphic description of a desert sandstorm and the sympathetic account of the Senussi and their headquarters, Kufara. The position assigned to Zieghen by Rohlfs was shown to be 100 kilometers too far east-northeast while the new determination for Kufara places it some 40 kilometers south-southeast of Rohlfs' position. Naturally it is the second half that is especially interesting dealing as it does with the unknown country and the discovery of the "lost" oases of Arkenu and Owenat. Kufara was left on April 18 and the most trying stages of the journey entered on. At first the route lay over a plain of hard sand covered with fine gravel where temperature proved the chief handicap, it being too hot for travel at midday, at night too cold. Later the terrain changed to high steep sand dunes very exhausting for the camels.

Arkenu, the first of the lost oases was reached 266 kilometers from the most southerly of the Kufara wells. Arkenu is a granitic mountain mass desolate and forbidding in appearance, but it proved to contain a fertile valley inhabited part of the year. "The Badawi, Tebus, and Goran bring their camels during the grazing season, close the entrance to the valley with rocks, and leave the camels there unattended for three months." Arkenu has permanent water, drinkable, though not of good quality. From Arkenu to the second oasis, Owenat, 42 kilometers, the expedition skirted the western foot of the mountain. The change in topography was agreeable. "It is so much easier to march with one's destination distinct before one than to be walking on that flat disc of a desert where every point of the compass looks like every other one and the horizon keeps always at the same maddening distance." The mountains at Owenat are higher, rising to over 1100 meters. This is reflected in the excellent quality of the water, for these oases evidently derive their supplies from meteoric waters preserved in sheltered rock pools. The mountains of Arkenu and Owenat cover an area of at least 1000 square miles. Their water resources suggest the possibility of opening to further exploration the southwestern corner of Egypt, hitherto inaccessible to military patrols. Arkenu occupies a strategic location at the meeting point of the western and southern boundaries of Egypt. Owenat has 150 inhabitants today and some interesting evidences of earlier human occupation in rock carvings of animals including the giraffe, now unknown in the country, but not the camel.

From Owenat to the first well of Erdi is 430 kilometers. There is no water but some patches of dried grass in the latter half of the route, and 25 kilometers before Erdi is reached valleys of green grass.

Hassanein Bey's route thence across the Erdi and Ennedi plateaus connects with Tilho's well known work to the west. His barometric levels confirm Tilho's conclusion that there is no possible drainage outlet from Lake Chad in an easterly direction.

Former Caravan Routes Through the Libyan Desert. In a recent number of *Petermanns Mitteilungen* (Vol. 70, 1924, pp. 219–223) Paul Borchardt discusses former caravan routes from Egypt and Nubia westward across the almost unknown Libyan desert into the mid-Sahara, to Tripoli, and to the central Sudan. He bases his investigation on information furnished by two writers of the eleventh century of our era—the Jewish traveler, Rabbi Benjamin of Tudela, and the Arabic geographer, Edrisi—as well as upon corroborating evidence drawn from other ancient, medieval, and modern authorities. His conclusions would seem to establish the former existence of three principal routes. The first of these ran from the Oasis of Dakhla through Kufara, Fezzan, Ghat, and Janet to Sebcha Amadghor on the

trade route from Tunis southward to the Sudan. The second route ran from Dakhla by way of Borku to Lake Chad. The third connected Massawa on the Red Sea with the Mediterranean, passing through Dongola and Kufara. Though modern lines of communication follow these routes in some of their stretches, the older lines for the most part have fallen into desuetude. It has been ascertained from the inhabitants of the desert, however, that even the worst desert crossings (as, for instance, those from Dakhla to Kufara or to Owenat) may still be used. In this connection we may note that Owenat, the point where the second and third of the main caravan routes crossed, has recently been visited for the first time by a trained observer, Hassanein Bey (see the note above).

The Mapping of the Western Frontier of the Anglo-Egyptian Sudan. Under date of January 21, 1924, the protocol defining the boundary between French West Africa, and the Anglo-Egyptian Sudan has been ratified (Treaty Series 28 (1924), Cmd. 2221, London). Within six months after a given date to be selected by the local authorities but not to be later than January 1, 1925, the natives on either side of the line are to choose the territory on which they wish permanently to reside (compare the note "Boundary Settlement and Exploration in Wadai and Darfur," *Geogr. Rev.*, Vol. 12, 1922, pp. 492–494). The work of demarcation of a portion of the boundary has been graphically described by Captain P. K. Boulnois in the June, 1924, number of the *Geographical Journal.* "The southern parts of this frontier, where the boundary follows the watershed [Nile-Congo], are covered by thick forests which decrease in density as the line runs northwards, until the terrain becomes more of a bush desert than a forest. This bush desert, also in gradually decreasing density, continues along the whole western frontier of Darfur until a broad sandy watercourse, known as the Wadi Howa, is reached. The boundary follows this wadi from west to east up to the point where it is crossed by the 24th meridian of eastern longitude, and it then turns up this meridian and follows it for 260 miles northwards to parallel 19° 30′ north. All this part of the boundary north of the Wadi Howa lies in true desert, amongst sandy wastes which have been aptly described as 'miles and miles of absolutely nothing.' At lat. 19° 30′ north the boundary turns northwestwards to reach another 'three-boundary point' where the third country involved is Tripoli."

Aside from a rough reconnaissance along the 24th meridian, mapping operations were confined to the portion of the boundary south of 16°, a stretch of 1000 miles. Adrei, on the frontier due west of El Fasher, was the starting point. Captain Boulnois' party worked north from here. The country is flat bush desert, the general height of the plain 3000 feet, with many small *jebels* affording good beacon sites. The wadis typically consist of a well-defined sandy bed along which water flows more or less torrentially during the rainy season; bush is of great density along the banks. In the beds, though bone dry for ten months of the year, water may usually be found by digging 15 feet or so. The natives grow their crops of dura and sometimes of cotton or tobacco on the banks and site their villages close to them. The most interesting feature of this section is the curious lake Undur in a region that is "singularly waterless." The lake is about two miles long and 500 yards in average width and very shallow: its waters dry up about the end of May. The Wadi Howa is of great width and an important grazing ground for camels.

The second season Captain Boulnois' party mapped the extreme southern section. This portion of the Nile-Congo watershed is described as a "winding line in the flattest of flat forests." The forests are dense with an undergrowth of thick tough grass which can be burnt off in the dry season. In this difficult country the only practicable mode of survey was by compass traverse, position being checked at stations established every 40 miles or so. The matter of supplies also constituted a serious problem, as there were no villages within 30 or 40 miles of the watershed on the Sudan side and none within 70 or 80 on the French Western African side.

Reference may also be made to the rectification of a section of the Eritrea-Sudan boundary with the setting up of frequent boundary marks where rich grazing or cultivable lands are crossed (Treaty Series 29 (1924), Cmd. 2222, London).

ASIA

Chinese Migrations. At the present time it is estimated that somewhat over 8,000,000 Chinese are resident abroad. Of these nearly 7,000,000 dwell in Formosa, the East Indies, and Siam. A quantity of highly interesting information concerning the history and conditions of Chinese migrations, past and present, to Formosa, the East Indies, the Philippines, British Malacca, Hawaii, and the Transvaal, and concerning the Chinese labor corps in France during the World War, has been gathered together and presented by Ta Chen in a volume entitled "Chinese Migrations, with Special Reference to Labor Conditions" (constituting *Bull. U. S. Bur. of Labor Statistics No. 340*), Washington, D. C., 1923.

Chinese oversea migrations began as early as the seventh century of our era with an extensive movement of population from the seaboard of China to Formosa and the Pescadores islands. In the fifteenth century a second wave swept into the Malay Archipelago and Philippines. The modern period began about 1860 "with the legalization of the coolie trade. Spain, Portugal, Holland, Great Britain, and other European powers were bent on developing their colonies and possessions commercially and industrially. They looked to China as an inexhaustible source of manual labor." The internal conditions of China added an incentive to emigration. It is believed that the total population of China increased from 174,857,000 in 1749 to 375,377,000 in 1920 (Post Office Census: the Manchurian provinces are included, Szechwan omitted. Compare Professor Roxby's paper in this number of the *Geogr. Rev.*) Farmers now constitute about 75 per cent of this immense total. The average size of the family in China is 5.5 and in Manchuria 8.3. The average size of the Chinese farm is 5.5 acres, which means that there is but one acre of farm land per individual in China. Under these conditions it would seem to be obviously "impossible for the farmer to produce enough food to support and educate his family properly." The existing population can hardly be maintained on the arable land now under cultivation.

Emigration is most active from the four provinces of Chihli, Shantung, Fukien, and Kwangtung. These have all suffered from recurrent droughts and famines. In Fukien, for instance, where conditions have been the worst, there have been 29 droughts in 246 years, or one every 8.5 years, and 20 famines in 219 years, or one every 11 years. The state of affairs has not been much better in the other three provinces. "It was natural therefore that the young and adventurous people . . . should leave their poverty-stricken homes to seek better opportunities in countries beyond the seas." Furthermore, emigration from these four provinces has been especially favored by their situation on the seacoast with ready access to fine harbors, as well as by the vitality and adaptibility of the people and by their "business acumen, coupled with grit and gumption." Add to these, the allurement of higher wages and of the prospect of bettering the standard of life, and emigration was inevitable.

Two main methods of stimulating emigration have been in practice. In the first place there has grown up an elaborate internal organization of emigration brokers and companies, which, by methods often unscrupulous and provocative of hardship and vice, have furnished the emigrant with transportation on a "credit ticket" in return for the equivalent of a mortagage on his earnings. The second method has been due to the enterprise of foreign governments or capitalistic companies seeking for the contract labor of Chinese coolies. The detailed history of Chinese emigration in modern times under these two systems, often a dreary enough story

of exploitation and corruption, is told by Mr. Chen, and for the British Empire alone by Persia C. Campbell in a volume entitled "Chinese Coolie Emigration to Countries within the British Empire," P. S. King & Son, London, 1923.

The presence of a large number of Chinese in a foreign land at best is an abnormal situation. Social, political, and economic discrimination against them seems inevitable. Mr. Chen proposes methods for remedying the situation: the stricter control and regulation of circumstances surrounding emigration. He also suggests certain far-reaching considerations of no little geographical interest. He believes that the distribution of population in China is ill adjusted to the distribution of arable land. Large tracts of unused arable land are known to exist in Kansu, Yünnan, Sinkiang, as well as in Manchuria, Mongolia, and Tibet, and interprovincial migration to these tracts should be encouraged. In the final analysis, however, he holds, optimistically, that the ultimate solution of the problem will come through education. "When education reaches the great masses, and fundamental laws of population are generally understood, families will be smaller and the material wants of the people can be satisfied with proportionately less effort, so that poverty may be diminished and the cultural level substantially raised; the needy may no longer be forced to emigrate in large numbers; and the socio-economic welfare of the people will be materially improved."

AUSTRALASIA AND OCEANIA

Note on Pitcairn and Henderson Islands (Central Pacific). These islands lie on the great circle track, half-way between the Panama Canal and Auckland, New Zealand, and, with the exception of Hood island in the Galápagos, are the only land to be seen over the entire distance. I had the opportunity of observing them under favorable conditions from the S. S. *Tekoa* on August 3, 1924. The vessel passed within a couple of miles of the north side of Henderson island about 9 A. M. in very clear weather, while Pitcairn was sighted in the afternoon, a stop of one hour being made within a mile of the shore between 5 and 6 P. M. The vessel was making a great circle course from Balboa to Auckland, and her position at noon on that day was longitude 128° 52′ W., latitude 24° 29′ S.

Pitcairn island (longitude 130° 5′ 55″ W., latitude 25° 4′ 0″ S.) is well known owing to the romantic story of its occupation by the mutineers of H.M.S. *Bounty*, but apart from the story little is heard of the place. The plan and sketches of the island which appear on Admiralty Chart No. 1113 are from a very old survey, but the physical description in the sailing directions (Pacific Islands, Vol. 3 (Eastern Groups), 4th edit., Hydrographic Dept., Admiralty, London, 1909, pp. 112–114) is good, though little can be deduced from it concerning the physiography or geology of the island. It states: "Pitcairn island is about 2¼ miles long east and west and one mile wide; the entire circuit of the island, with one or two exceptions, is perpendicular. The highest point being about 1000 feet above the level of the sea renders it visible 40 miles distant. The soil is very rich and fertile but porous; a great proportion is decomposed lava, the remainder a rich black earth. The island is thickly clothed to the summit with luxuriant verdure, terminating in lofty cliffs, skirted at their base with thickly branching evergreens." The appearance of the island in approaching it from the northeast is very striking. The cliffed coasts truncate a well developed topography most abruptly, evidently on all sides. Seen from the northeast the cliffs on the southern end of the island attain a height of about 450 feet, while those on the northern end are about 250 feet. The cliff faces are straight and make an angle of about 70 degrees with the horizontal. There are a few low pinnacles and stacks flanking the island close inshore. Above the level of the cliffs the habitable surface sweeps in verdant folds up to the summit. The cliff exposures show a pronounced stratification of the material, which, judging from its

color, a bright reddish brown, its comparatively fine bedding, and the geological feeling about a place seen from a distance, is tuffaceous. It evidently weathers rapidly. The dip ranges from 25 to 40 degrees, in a north-northeasterly direction. Solid rock appears to outcrop in places, especially around the base of the cliffs in Bounty Bay, and there is some appearance of dikes. This structure prevails around the northern corner of the island. It indicates that Pitcairn is not itself a dissected volcano but merely the dissected flank of one. It resembles Gebel Zebayir, off Zukúr in the Red Sea, and the remnants of Krakatoa.

Adamstown, the settlement, occupies a gentle ledge at the top of the cliffs on the middle of the northeastern side. Thirty-eight buildings were counted from the deck of the *Tekoa*, all surrounded by luxuriant cultivation, some of them quite substantial and attractive in appearance. Sixty-eight of the islanders came out to the vessel, in three boats, and all but the women clambered on board. They bartered subtropical fruit (mainly bananas and oranges) and curios—which reveal an interesting fusion of European and Polynesian culture—for wood, old tools, nails, flour, etc. They are a healthy, simple, though by no means dull-witted people and reported themselves to be contented and prosperous and between 150 and 160 in number. There is a great diversity of types, a few (especially women) being dark-skinned and Polynesian in appearance. One man had straw-colored hair, but most of them would pass for Europeans. The majority were barefooted but otherwise well clad. They sell and barter their goods to emigrant vessels, for money, clothes, and other necessities; and some of them are saving money. A few men have been away from the island as far as England. They would like to attract a little new blood to the settlement. They are not illiterate and have postal arrangements, though no stamps, and a wireless receiving set of limited range (about 200 miles) which can receive at the rate of ten words a minute.

These people are dependent upon passing vessels for staple necessities of life. They are fortunate in being situated on a main highway of the sea, and they realize it. Nearly all the ships going that way make a call at the island, if only to check their chronometers; but, owing to the difficulty of landing, very few strangers ever go ashore. The population receives no additions from outside. We have here an absolutely isolated group of people whose ancestry is traceable from their earliest occupation of the island, a mixed ancestry of British mutineers and Tahitian women. They should form an important subject for genetic research, and it is hoped that they will not escape the attention of students. Were the direct route abandoned in favor of an outward passage via Tahiti and a homeward one via Easter island, alternatives that offer slight advantages of wind and current, the standard of life on Pitcairn would return to a much more primitive level.

Henderson island (longitude 128° 18′ 30″ W., latitude 24° 24′ 45″ S., plan on Admiralty Chart No. 1176) is uninhabited and is a dependency of Pitcairn. It is said to be visited occasionally for copra. The sailing directions (*op. cit.*, pp. 111–112) describe it as follows: "The island is five miles long north and south, 2½ miles wide near the northern end, but tapering off to a point towards the south, and has a flat surface nearly 80 feet above the sea. On all sides except the north it is bounded by perpendicular cliffs about 50 feet high, composed entirely of dead coral, which are considerably undermined by the action of the waves. It appears to be steep-to at a short distance all round." Other passages suggest that the whole island consists of rough coral rock and that it is waterless, except for small pools of rain water. Some sheds were erected on the northern side a few years ago. Rockets and detonators were fired from the *Tekoa*, but a close examination with telescope and binoculars revealed no signs of life, nor were the sheds observed. The cliffs overhang in places. The marked undercutting attains a height of about eight feet above the surface of the sea. Above this, at a height of about 20 feet above sea level, there is a marked cave level in the cliffs, to be seen even in those that curve inland behind

the beaches on the north side. This level is so well defined, and the caves are so unlike the results of wave action (their floors are level and concordant), that they suggest a former relation to ground-water level and a negative movement of the strand, of the kind required by Daly's hypothesis. (See R. A. Daly: A General Sinking of Sea-Level in Recent Time, *Proc. Natl. Acad. of Sci.*, Vol. 6, 1920, pp. 246–250, and *idem:* A Recent Worldwide Sinking of Ocean-level, *Geol. Mag.*, Vol. 57, 1920, pp. 246–261.)

These two lonely neighbors, 114 miles apart, the larger low, flat, and uninhabited, the smaller high, rugged, and inhabited, the one coralline, the other volcanic, are southern outposts of Polynesia. What their geological relationship may be it is impossible to say. Soundings are regrettably few in the Central Pacific, but Henderson and Pitcairn islands would seem to belong structurally to the submarine platform of the Tuamotu or Low archipelago.

M. Aurousseau

POLAR REGIONS

The Oceanography of Barentz Sea and the Climate of Northern Europe. Recent oceanographical explorations carried out by the Murman Biological Station of the Petrograd Natural History Society in coöperation with the Northern Scientific-Industrial Expedition have contributed materially to our knowledge of Barentz Sea and, incidentally, have suggested a new means of arriving at long-range weather forecasts for the extreme north of Europe. The results of the explorations are presented at length in the *Transactions of the Northern Scientific-Industrial Expedition*, No. 19, Moscow-Leningrad, 1924 (in Russian), and more briefly in an article by Professor K. Derjugin of the University of Leningrad ("Das Barents-Meer längs dem Kola-Meridian (33° 30′ östl. L.)," *Internationale Revue der gesamten Hydrobiologie und Hydrographie*, Vol. 12, 1924, pp. 145–174). The most important incidents in the work were the carrying out of careful surveys in May and August, 1921, along the meridian of Kola as far north as latitudes 72° 30′ N. and 75° N. respectively. In May soundings were taken at intervals of 30′, in August at intervals of 10′.

Barentz Sea as a whole covers part of a broad northerly extension of the European continental shelf which reaches beyond Spitsbergen, Franz Josef Land, and Novaya Zemlya. The sea floor on the whole is remarkably level, ranging along the Kola meridian (to latitude 75° N.) from depths of 144 to 317 meters. The bottom is strewn with rock fragments, varying in size from large boulders to gravels and grits, carried north by a former continental ice sheet. As far north as latitude 73° N. these deposits are covered with organic ooze, but from 73° to 75° the ooze is generally absent, presumably on account of strong currents along the bottom.

The play of the ocean currents and its resulting effects upon the temperature of the water present a complicated problem. In general two conflicting drifts meet in the vicinity of the Kola meridian: from the west a warm drift from the Atlantic, the ultimate continuation of the Gulf Stream, and from the east a drift of colder water. These interpenetrate each other, forming under normal conditions a series of four alternate wedge-like strips of warmer and colder water with axes running east and west. This condition, however, is by no means static: at some times the colder and at other times the warmer water pedominates. There is an annual expansion of the warm drift from the Atlantic which may result in the complete elimination of one or more of the cold wedges and in the coalescing of one or more of the warm ones. This condition was observed in August, 1921. There also appear to be longer periods of oscillation forming what is probably an eight-year cycle. The years 1898, 1906, 1913–1914, and 1920 were characterized by an excess of relatively warm water; the years 1902, 1909–1910, and 1916–1917 by an excess of relatively cold water.

Dr. Derjugin believes that there is a direct relation between these thermic fluctuations in Barentz Sea and the climatic régime of northern Scandinavia and northern Russia. It is noticeable that the periods of warmer water seem to correspond to mild winters and early springs.

In Dr. Derjugin's opinion climatic oscillations are to be associated rather with thermic changes in the sea water at all depths than with the presence or absence of floating ice. The circumstances governing the movements of the ice in Barentz Sea in any case are not well understood, though it is probable that the winds exert more influence in this respect than does the temperature of the water. Indeed, it has occasionally been observed that the ice has been altogether absent during seasons when the temperature of the water was the lowest.

Other matters of interest touched upon in Dr. Derjugin's report have to do with the salinity and oxygen content of the waters and with marine biology. Salinity was observed to vary directly with temperature: the warmer the water, the more saline. The oxygen content of Barentz Sea was in general high, testifying to active convectional movements producing a marked aeration particularly in the more southern latitudes. Dr. Derjugin classifies the marine life of Barentz Sea as *sub-arctic* rather than *arctic* (his categories in the Northern Hemisphere being *arctic*, *subarctic*, *boreal*, *subtropical*, and *tropical*), even though the sea lies far north of the Arctic circle. This is of course due to the influx of warm water from the Atlantic.

French Claims in Antarctic and Sub-Antarctic Lands. The no-man's lands of the earth are vanishing. Claims to oceanic islets or polar lands are being substantiated by that effective occupation which Mr. F. W. S. Cumbrae-Stewart describes as "the only basis of territorial right likely to be recognised by the law of nations" (Geographical Discovery as a Basis of Territorial Right, *Queensland Geogr. Journ.*, Vol. 38 (N. S.), 1922–23, pp. 61–78).

In the 1870's Russia, alarmed over the frequenting of Novaya Zemlya by Norwegian sealers, began colonization of this heretofore uninhabited land. Recently Novaya Zemlya and smaller adjacent islands have been placed under a newly created "Islands Administration" with headquarters at Archangel. Norway has recently had her sovereignty over Spitsbergen confirmed—a recognition of her effective work in opening up the archipelago to development. Britain has defined two sectors of the Antarctic as part of the Empire, and the recent change attributing the Ross Dependency to New Zealand (*Geogr. Rev.*, Vol. 14, 1924, pp. 314–315) is in the line of more effective control. France now follows with declaration of rights over the Crozet Islands and Adélie, or Wilkes Land, "long overlooked but today clearly recognized as forming an integral part of the French colonial domain" (Gustave Regelsperger: Les Îles Crozet et la terre Adélie, *L'Océanie Française*, Vol. 20, Paris, August-Sept., 1924, pp. 137–138).

A decree of March 27, 1924, countersigned by the Minister of the Colonies, reserves to Frenchmen the mining, hunting, and fishing rights in the territorial waters of the Crozet Archipelago and on Adélie, or Wilkes Land. A decision of the Ministry of Marine on March 26, 1924, places the Crozet Islands in the zone of naval surveillance of the Indian Ocean, Adélie Land in that of the Pacific.

The Crozet Islands lie between latitude 46° and 47° S. and longitude 51° and 52° E. (Greenwich), south of Madagascar and west of Kerguelen Island, close to the direct route from the Cape to Australia. They were discovered by a French expedition under Captain Marion-Dufresne in 1772 and were formally annexed by France in 1913. These volcanic isles lie in seas supporting a rich fauna, at present undepleted as are the waters of some of the more frequented sub-Antarctic islands. This has been the case with some of the more accessible islands south of New Zealand and threatens Macquarie Island, as Sir Douglas Mawson points out in advocating establishment of this island as a National Faunal Reserve (Macquarie Island and its Future,

Papers and Proc. Royal Soc. of Tasmania for the Year 1922, Hobart, 1923, pp. 40–54). It is suggested that the Crozets would serve as a central station for an important fishing industry.

In 1840 the Frenchman Dumont d'Urville and the American Charles Wilkes sailed simultaneously along a section of the Antarctic mainland in the Australian Quadrant. D'Urville effected a landing on one of the rocky islets fringing the coast and took possession for his country. According to Regelsperger the Antarctic coast claimed by France lies between longitude 134° and 140° E. (of Paris) and latitude 66° and 67° S. The scarped granitic coast is entirely barren: its sole known wealth lying in the sea birds and mammals that frequent the shores.

OCEANS

The Sargasso Sea. The region lying between the Azores and the Bahamas—a stretch of more than two thousand geographic miles—is exceptional in many respects. Within the central portion of this region the waters are of an unusually deep blue color and of exceptionally high temperature and salinity. And it is within this region that the Sargasso Sea lies—an area characterized by the prevalence of *Sargassum*, or "gulfweed," floating on the surface. The first notice of the occurrence of gulfweed in this region is coincident with the discovery of the New World, record having been made of the fact by Columbus himself on his first voyage. Notwithstanding this, the origin of the gulfweed has been a controversial question to the present time.

The earliest theory regarding the origin of the gulfweed was based on the assumption of banks near the Azores and Bermuda on which the *Sargassum* grows. The sounding lead however, soon showed the depths in this region to be altogether too great for the existence of such banks. Following this, two diametrically opposed theories have held sway. The first held the gulfweed to come from the shores of the West Indies and the Bahamas, from which it is carried by the Gulf Stream into the Sargasso Sea. According to the second theory *Sargassum* is a free-floating plant in the Sargasso Sea, which propagates vegetatively by partition, thus keeping up the supply. Krümmel in "Die nordatlantische Sargassosee" (*Petermanns Mitt.* Vol. 37, 1891, pp. 129–141) lent the weight of his authority to the former theory, and this has generally been the accepted view.

In a brochure entitled "The Sargasso Sea, Its Boundaries and Vegetation," published April 30, 1923 (Report on the Danish Oceanographical Expeditions 1908–10, to the Mediterranean and Adjacent Seas, Vol. 3, Miscellaneous Papers), Dr. Ö. Winge examines the question in the light of recent observations and on the biological evidence comes to the conclusion that the drifting sargasso weed does not come from the coast but lives and propagates by partition in the Sargasso Sea. He stresses the fact that the drifting sargasso weed is destitute of the ordinary organs of reproduction which are found on the attached coastal forms. Furthermore, the species of *Sargassum* occurring in the Sargasso Sea have not been found growing attached anywhere along the coast. Winge finds that the vegetation of the Sargasso Sea consists principally of three common species of *Sargassum* which occur over the whole area. These live and propagate vegetatively year after year and exhibit a distinct optimum period of growth in the latter part of the summer.

On the basis of the more recent observations Winge attempts a new delimitation of the Sargasso Sea. This does not exhibit the regular oval outline which since Krümmel's time has been the accepted delineation. On the east Winge draws the boundary in longitude 27° W.; the southern limit he places at latitude 30° N. on the east and somewhat below latitude 20° N. on the west. The northern limit is just above the fortieth parallel on the east, swinging thence southwestward to latitude 35° N., from which point it turns sharply north to latitude 45° N. and then follows

the coast of North America as far as latitude 40° N. The western boundary Winge does not attempt to draw, since the material at hand was not sufficient for the purpose, but he is of the opinion that it should follow the eastern coast of North America at some distance from the shore. The northerly extension of the western portion of the Sargasso Sea is obviously brought about by the Gulf Stream.

H. A. Marmer

The Gulf Stream. Of the two great currents that make up the Gulf Stream, the leading rôle has heretofore been assigned to the Antilles Current, and this despite the greater velocity of the Florida Current. In regard to the quantity of water as well as the quantity of heat transported by the Gulf Stream, it has been accepted that the greater portion was contributed by the Antilles Current. For instance Krümmel, in his "Handbuch der Ozeanographie" (Vol. 2, Stuttgart, 1911), credits the Antilles Current with contributing about two and one-half times as much water and heat as the Florida Current.

These questions are considered anew in a hydrodynamic study of the Gulf Stream by Georg Wüst (Florida- und Antillenstrom: Eine hydrodynamische Untersuchung, *Veröffentl. Inst. für Meereskunde*, N. F., A. (Geographisch-naturwissenschaftliche Reihe), No. 12, 1924). In this study the author discusses the observations made by Bartlett and by Pillsbury in the seventies and eighties of the past century and the more recent observations of the U. S. Coast and Geodetic Survey Steamer *Bache.* Examining critically the older observations, he comes to the conclusion that these observations deserve greater appreciation than has been accorded them at times by modern research and finds that a reworking of this older material brings to light new features. He then treats the data by the method of dynamic sections developed by Bjerknes and shows that the results derived are in good agreement with the observed values. The temperature inversions found by Bartlett, which were rather lightly regarded by the majority of oceanographers, are shown to be features necessitated by the dynamics of the case.

The prevailing conception of the Florida Current as a "river in the sea" comprising a body of northerly-flowing warm water reaching to the very bottom, Wüst shows to be erroneous. With regard to the vertical distribution of the hydrographic features, the waters of the Florida Current are not homogeneous but exhibit a very decided stratification, and the author directs attention to the importance of this fact in the evaluation of data based on biological hauls. With regard to the relative quantities of water and heat contributed by the Florida Current and the Antilles Current, Wüst's calculations show that the latter is the lesser contributor, the Florida Current contributing about twice as much water and heat as the Antilles Current. The author concludes that the very considerable amount of heat with which the Gulf Stream is freighted comes principally from the branch issuing through the Strait of Florida.

H. A. Marmer

PHYSICAL GEOGRAPHY

An Ecological Cycle in Valley Development. In a brief paper on "The Cycle of Development of Vegetation in the Valleys of the Steppe Zones of Eurasia," published in the *Izvestia* of the Geographical Institute of Petrograd for 1922, I. M. Krasheninnikov has outlined an interesting method for study of the evolution of river valleys from the botanico-geographical point of view. Embracing in his analysis a broad region from the Ukraine to Turan, variegated in local botanical details, he finds that "for this whole vast territory, the evolution of the vegetation of the valleys (lake as well as river) works out in a single definite and clearly expressed geographical cycle, having . . . much in common with Davis' geographical cycle." The

principle of this cycle is simple: the hydrological régime characteristic of each stage in a valley's development favors certain types of vegetation, determined locally by other ecological factors, as climate, soil, etc. Applying this principle to the region under analysis, and more particularly to the valley of the Don, the writer finds three principal stages in the ecological cycle, manifested by different types of vegetation: fresh-water marshes in youth, salt marshes in maturity, and steppe in old age. The course of the cycle is accelerated, set back, or started anew by changes in the valley's base level; and the different stages commonly exist side by side on successive terraces.

The weakness of the entire system, and the respect in which the analogy with the Davis cycle is faultiest, lies in the greater difficulty of employing any one of its phases to characterize a landscape as a whole. Owing to complications of the physiographic cycle, more than one of its phases are often presented in a single view; but the conditions of the earlier phases of the ecological cycle necessarily cling to the flood plain of a river throughout the later stages of the physiographic cycle as described by Davis. Zones of vegetation characteristic of both youth and maturity thus normally persist in the midst of a predominantly steppe landscape indicating old age. Application of the terminology of this system to general regions, then, could be made only on a basis of relativity. The existence of relatively large areas of vegetation of one type or another would offer some indication of the ecological, and consequently the physiographic, age of the region as a whole. Within its limitations, the botanico-geographical method outlined by Krasheninnikov should prove a useful factor in the analysis of landscape. Its application to other regions than that which he has studied suggests some interesting possibilities of investigation.

J. V. Fuller

What is a Desert? "Was ist eine Wüste?" is the title of an important lecture by Professor Erich Kaiser of Munich recently published in the *Mitteilungen der Geographischen Gesellschaft in München* (Vol. 16, No. 3, 1923, pp. 1–20). Most studies of deserts, Kaiser contends, have been unsatisfactory because they have neglected to take into consideration one or more of several important features which combine to lend distinctiveness to the arid tracts of the world. This lecture is a successful attempt toward clarifying thought in regard to a complex and difficult subject.

Kaiser accepts Penck's definition of the arid climatic realms as realms in which evaporation exceeds precipitation, though he is careful to explain that this is true only when long periods of time are taken into consideration. He divides the arid climatic realms themselves into semi-arid, normally arid, and extremely arid zones. Desert conditions are in general confined to the two latter zones, the outstanding difference between which is due primarily to the character of the precipitation in each. In the normally arid zone precipitation is periodic. There is a season of limited, though fairly regular, rainfall during which vegetation springs up and the ground-water table is replenished; dry farming is sometimes possible. In the zone of extreme aridity, on the other hand, the rainfall is episodic. Coming only at rare and irregular intervals, it is likely to come in the form of cloud-bursts. After such catastrophic rains there blossom forth seeds, which perhaps have lain dormant for years on end. But the resulting vegetation cover, luxuriant for the short while that it lasts, soon withers and disappears.

Physiographic processes are also widely different in these two zones and produce marked variations in the character of the landscape. Deflation, for instance, or the removal by the winds of materials disintegrated by other forces, though characteristic of all parts of the desert, progresses much more rapidly and on a relatively larger scale in the extremely arid zone than in that of normal aridity, and corrasion, or wind sculpturing, is almost exclusively confined to the former. Aeolian sedimen-

tation, however, or the deposition of materials carried by the winds, goes on even beyond the limits of the desert. The most striking difference between the normally and extremely arid zones is associated with the work of surface waters. The wide, waste-covered tracts so characteristic of Southwest Africa (and, we may add, of our Great Basin region) made up of detrital material washed down from higher ground by sudden, broadly spreading floods (*Schichtfluten*, *Oberflächenspülungen*) are to be found throughout the arid realms of the world. In the normally arid zones, however, these are associated with the usual land forms produced by fluvial erosion. In the extremely arid zones, on the other hand, they are modified by the action of the winds which may convert parts of them into "typical landscapes of deflation and corrasion."

A point stressed by Kaiser, obvious but sometimes overlooked, is that the borders of the desert and the different climatic zones within the desert are not stationary. They shift continuously with the seasons, with longer climatic cycles, and with climatic changes reckoned in terms of geological time. A close juxtaposition of evidences of different types of climate in the geological record, therefore, should not necessarily be interpreted as indicating rapid and radical changes in general climatic conditions. It may simply reflect local passings back and forth of a climatic frontier over a given point.

Nor are the boundaries between the different zones of aridity sharp and well-defined lines. There is not only a gradual merging of one zone into another, but numerous isolated phenomena of one zone are frequently found wholly enclosed within its neighbor. Active eolian corrasion, for instance, may progress at an isolated point in the normally arid zones. Isolated phenomena of this sort are due to a wide variety of local causes. Different orographical relationships produce varied effects of wind and insolation. Different qualities of rock produce varied types of disintegrated rock waste; these affect the level of the ground water, which, in turn exerts a marked influence upon vegetation. Relicts of formerly existing conditions often maintain themselves within regions whose general character has been materially altered, and even the work of man may introduce areas characteristic of the desert into less arid zones, as where the burning or cutting of forest or prairie grass gives rise to "bad-lands topography."

HISTORY OF GEOGRAPHY

Geography Among the Babylonians and Egyptians. Figure 1 is a reproduction of a map of the world on a Babylonian tablet. The black dot in the center is probably the city of Nippur, which the Babylonians believed to be the navel of the world, as the Greeks conceived of Delphi and the medieval Christians of Jerusalem. The broad circular band is the "salt river" surrounding the *oikoumene*. The parallel lines, *a* and *b*, are probably the Tigris and Euphrates rising in the all-encircling river and flowing southward through a mountainous region, *e*. The cross lines, *c* and *d*, may be the present Shatt en-Nil and Nahr Isa, transverse canals connecting the two great rivers. Assyria is shown by the circle, *f*.

These and other interpretations of this map are given by Professor H. F. Lutz in a recent article entitled "Geographical Studies Among Babylonians and Egyptians" (*American Anthropologist*, Vol. 26 (N. S.), 1924, pp. 160–174). The map dates from Neo-Babylonian or from late Babylonian times: that is, from a period when the actual sources of the Tigris and Euphrates were known and when the Mesopotamian peoples could scarcely "still have maintained the idea that their country . . . made up the bulk of the earth." Professor Lutz concludes therefore that the map reflects ideas current in a much earlier period and that it bears witness to the inability of its authors "to formulate the accumulated knowledge of later centuries in

new ways, or even to square this more recently acquired knowledge with the older views."

Modern students have exaggerated the extent of the geographical knowledge of the Babylonians and Egyptians. References in Babylonian date formulae to the existence of bronze and copper maps and also lists of countries and districts, itineraries like those of the Romans, and other evidence show us that the early inhabitants of the Tigris and Euphrates valleys were interested in geography from a practical point of view.

The Ionian Greeks probably borrowed from the Babylonians the conception shown in Figure 1 of a disk-shaped earth surrounded by an ocean stream and bordered on the north by a region of mountains. These were doctrines destined to exert a lasting influence on Hellenic and medieval geographical theory. There were also some among the Babylonians who thought that the earth is a quadrilateral, corresponding exactly to a quadrilateral formed by stars in the constellation Pegasus. The Tigris and Euphrates were associated with the outlines of a stellar trapezium and "two additional watercourses, which later tradition designated as Pishon and Gihon, completed the watercourses around the trapezium." It is to be remembered that Tigris, Euphrates, Pishon, and Gihon were the four rivers of Paradise of Genesis which in medieval tradition were interpreted as going forth to water the entire earth.

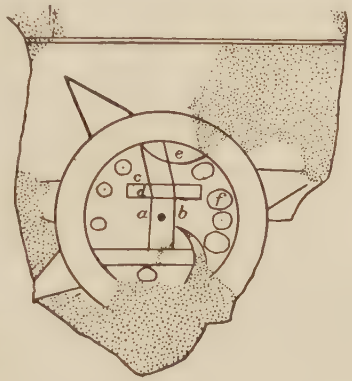

FIG. 1—A Babylonian map of the World.

Egyptian geographical investigations were not dissimilar to those of Babylonia. Geography of a sort was taught in the schools of Egypt, and knowledge of cities, regions, and distances between places was prized as of practical value for those who would qualify for the "civil or military service in foreign countries about the time of Rameses II." The same kind of astrological comparisons were made by the Egyptians as by the Babylonians, the Nile being supposed to correspond to the ecliptic.

On the whole, extreme conservatism was characteristic of the geographical science of the ancient Near East, a conservatism that contrasts with the more open-minded attitude of the Ionian and Hellenistic Greeks. As Professor Lutz observes, "when once the pernicious doctrine was evolved that whatever happens in the skies happens on earth, and that one has only to read the map of the sky in order to be enabled to come to an understanding of the earth, it meant a check to any serious progress in the field of geography."

GEOGRAPHICAL NEWS

Obituary

Alfred Hulse Brooks. On Saturday, November 22, 1924, occurred the untimely death at the age of fifty-three, of Alfred Hulse Brooks. He was chief of the Division of Alaskan Mineral Resources of the U. S. Geological Survey, vice-chairman (1911–1912) of the Alaska Railroad Commission, president of the Washington Academy of Sciences (1921) and of the Geological Society of Washington (1911). Already in 1913 his devoted service in Alaska had been recognized by the award of the Charles P. Daly Gold Medal of the American Geographical Society for the "excellence and importance of his work in the exploration and mapping of Alaska." At the same time a like award was made by the Geographical Society of Paris.

Among his publications the most noteworthy are his famous "Geography and Geology of Alaska," *U. S. Geol Survey Professional Paper 45*, 1906; "The Mount McKinley Region, Alaska," *U. S. Geol. Survey Professional Paper 70*, 1911; and a work (with La Croix) entitled "The Iron and Associated Industries of Lorraine, the Sarre District, Luxemburg and Belgium," *U. S. Geol. Survey Bull. 703*, 1920. Among his many special articles on Alaska probably the best is the one in the current number of the *Geographical Review* to which he gave more than ordinary care and which was one of his major preoccupations during the past summer. It should also be noted among his achievements that it was he who first proposed the publication by the Society of *Bering's Voyages* and thus the preservation of first-hand records of the original exploration of northwestern North America, the originals of which, in the files of the Russian Hydrographic Office, have since been lost. In 1915 he was offered a professorship in geography at Yale University but declined on account of what he believed to be moral commitments to the U. S. Geological Survey and especially to his loyal associates in the Alaskan work. In 1917 he was commissioned chief geologist of the American Expeditionary Force in France, and in that capacity he served with brilliant success until 1919 with the rank, successively, of Captain, Major and Lieutenant Colonel. A short but valuable paper on this work is "The Use of Geology on the Western Front," *U. S. Geol. Survey Professional Paper 128-D*, 1920. He was also attached for a short time to the American Commission to Negotiate Peace.

This brief record serves to indicate the quality of his professional work, but it would be inadequate not to add a reference to the friendly spirit which he maintained in all his personal relations and to the rare and impersonal judgment which he always brought to the counsel table. It was an essential quality of the man that his views were always modestly expressed. He thought a thing through and said what he thought and let it go at that, taking counsel to be sure but as a scientist not as a politician. He brought to his professional work a rich inheritance of mind and high standards of public service, driving through tasks regardless of his health, and anxious only that the work with which he was associated should be done for the permanent record and not for the fleeting years.

Edouard Gaston Deville died at Ottawa, September 21, 1924, aged 73 years. Dr. Deville rendered distinguished service to the Canadian Government for a period extending over half a century. At the time of his death he was in charge of the Board of Topographic Surveys and Maps, with the title of Director General of Surveys. A brief biographical note of Dr. Deville was given in the *Geographical Review* (Vol. 13, 1923, p. 461) when announcement was made of his election to Corresponding Membership in the American Geographical Society.

GEOGRAPHICAL REVIEWS

Aspects of European Geography

Mark Jefferson. **Man in Europe: Here and There.** 211 pp.; maps, ills. Ypsilanti, Michigan, 1924. 7½ x 5 inches.

Jefferson has worked some ripe philosophy into this book. It barely exceeds two hundred pages in a rather drab binding (but such as Ypsilanti, a town of 8,000, need not be ashamed of). The Sunday literary supplements will not notice it, but as an intellectual lever it should tilt the geographical world a little. There is no appendix of unvitalized statistics, no mere paraphernalia of scholarship, no gaudy illustrations, no waste of words. There are a goodly number of really geographical photographs with telling one-line captions, several original city maps loaded with geographical significances, outline maps in an unfinished state with directions for completing, so that you as reader have work to do before you reap the otherwise too-easy reward of Jefferson's thought, penetrating comments and questions, critically selected quotations from great literature. You have a growing sense of accomplishment as you advance from chapter to chapter to the end. One critic has well described the book as a grateful breeze blowing through an open window (this reader of course has his window open most of the time); another critic has equally well described the author as a man with no echoes in his mind.

It is a great thing to have done a little book like Jefferson's "Man in Europe." It is the issuance after toil. He has lived in France, Italy, Norway, and England. He speaks French and Spanish, not only as the result of book knowledge but also and particularly as a man who has lived a language with its people. Beside his condensed and thoughtful paragraphs, how barren seem so many other descriptions of European geography! The tyranny of that which has been still exercises its strange power over each successive writer. Jefferson's book is no "mine of information;" it is cut glass and hammered gold. Though intended for normal-school classes it should be used in every university course on the geography of Europe. It will teach the most mature student how to think more effectively in geographical terms. In it are no winds of current opinion, only basic things that influence and grow out of that solid folk life that survives dynasties and wars and gives geography its substantial content as a science. The list of chapters gives you no indication of the tone of the book, but for those who want headings here they are: Europe the Leading Continent; Distribution of Population; The Cities; Wealth; Some Pictures; What the European is Like; Climate; The Contest for the Northern Plains.

Geography of Serbia

Norbert Krebs. **Beiträge zur Geographie Serbiens und Rasciens.** iv and 226 pp.; maps, diagrs., ills. J. Engelhorn, Stuttgart, 1922. 9 x 6 ½ inches.

One naturally anticipates a substantial work if it is undersigned by Krebs. This treatise constitutes no exception. During the war Krebs made two excursions into the Morava and its tributary valleys, covering primarily the western portions of the drainage basin. While his observations have somewhat the character of a reconnaissance survey, yet, with careful checking against the literature covering the region, he has given them an authoritative stamp which may be accepted as reliable.

The discussion takes on the nature of a regional study. Krebs departs, however, from the common method of systematic treatment, which begins with surface features and ends with man's responses. He also considers the basin of the Morava not as a single region but rather as made up of several regions, each one including the

territory immediately contiguous to the main stream and to its smaller tributaries. The valleys of the larger tributaries are treated separately. The interstream areas, where distinctly hilly or mountainous, are in some instances considered as units.

Each region is discussed in much the same manner, but the elements are not always presented in the same sequence. Topography, climate, agricultural development, mode of living, are all considered in a more or less mixed fashion, whereby is presented a picture as nearly as possible like the conditions as one might view them from a train window. The reader is not put to the necessity of selecting out the geographic parts applicable to a given small area in order to reconstruct the landscape. Whether this method is always desirable need not be here determined, but where exact and detailed data are lacking, as they are for Serbia, this method of description seems to serve well.

The book begins with a survey of the literature on Serbia, indicates the occasion for the field work, and continues in the first chapter with a discussion of Belgrade. The city is presented in all its aspects, its history, its status at the opening of the war, the effects of the war, the significance of its location as the capital of Serbia, and, as the author believes, its present geographic unfitness as the capital of Jugoslavia. As the capital of Jugoslavia the author's preference is for Uskub.

In succeeding chapters Krebs launches into analyses of the land forms and the human responses in the respective regions of Serbia as indicated above. Geologic and topographic sketch cross sections, accompanied by selected photographs, illustrate the descriptive matter in a way to emphasize the points made in the text. Bibliographic references are numerous throughout.

Eugene Van Cleef

A New Classification of Climates in the Caucasus

I. V. Figurovski. **Klimati Kavkaza [Climates of the Caucasus].** 236 pp.; map. Tiflis, 1919. 9½ x 6½ inches.

Finding all previous attempts at classification of the varied climates of the Caucasus too vague and loose, the author of the present study has undertaken a most rigorous and detailed survey, with close attention to the minutest local differences. Detailed observation is required by the diverse conditions of this region, presenting strongly marked changes within narrow limits of distance. The influence of the seas bordering the region on the east and west is limited by the regularity of the coast line, which bears a smaller ratio to the total area of the land than prevails for the entire continents of Europe, North America, and Australia. The elevation, moreover, mounts rapidly to the high mountain chain crossing the isthmus diagonally; while to north and south lie plains and plateaus of steppe or even desert character, the dry winds of which dominate over large areas of the isthmus itself. All these conflicting influences produce the most abrupt climatic variations both regional and seasonal. Mean annual rainfall varies locally from 2500 to 150 millimeters, mean annual temperatures from 15° C. to below 0°. The amplitude of temperature changes runs as high as 32°.

For his regional classification the author has adopted the earlier system of Köppen ("Versuch einer Klassification der Klimate, vorzugsweise nach ihren Beziehungen zur Pflanzenwelt," *Geogr. Zeitschr.*, Vol. 6, 1900, pp. 593–611 and 657–679), with its elaborate scheme of symbolic designations by letters and numerals. (For a comparison with Köppen's system of 1918 see R. De C. Ward: A New Classification of Climates, *Geogr. Rev.*, Vol. 8, 1919, pp. 188–191.) On the basis of Köppen's factors, four main climatic "types" and eleven subclasses are distinguished, some of them recurring in separated localities. The resulting map of climatic "provinces" is as complicated as an ethnographic map of the same troubled territory. These provinces vary in character from the "moist subtropical" region of the

Black Sea coast to the "polar" region of the mountain crests, with the "mountain-forest province" forming the most extensive characteristic type of the interior. Each province is described separately with a wealth of detailed data. The minuteness of division and classification and the rigidity in adherence to the Köppen system detract from the general interest and value of the work.

The most interesting region described is the Black Sea coast between Batum and Tuapse which possesses a climate similar to that of South China rather than to that of the Franco-Italian Riviera with which it is commonly compared. The rainfall runs generally between 1000 and 2000 millimeters yearly (over 2500 at Batum), with relatively slight seasonal variations. Changes in temperature are likewise small—generally between 5° or 6° and 23° or 24°—the heat of the sun being tempered during the day by pleasant sea breezes. The prevailing winds are in the nature of the monsoon. Such a climate has proved favorable to the cultivation of citrus fruits, Turkish tobacco, tea, and sugar cane. Occasional cold waves are known, however, and the great affliction is the violent and destructive winter wind from the mountains, like the bora of Mediterranean countries. The climate of the dominant forest zone of the interior resembles in general that of the forest regions of Central Russia.

J. V. Fuller

Harbor Construction in Antiquity

Karl Lehmann-Hartleben. **Die antiken Hafenanlagen des Mittelmeeres: Beiträge zur Geschichte des Städtebaues im Altertum.** *Klio, Beiträge zur alten Geschichte*, Supplement 14. x and 304 pp.; maps, ills., index. Dieterich'sche Verlagsbuchhandlung, Leipzig, 1923.

Modern studies of ancient harbor works are few in number, and most of them wholly inadequate and full of misapprehensions. Among the best may be mentioned Ardaillon's "Quomodo Graeci collocaverint portus atque aedificaverint" (Inaugural Dissertation, University of Lille, 1898), which forms the basis of Besnier's article "Portus" in the Daremberg-Saglio "Dictionnaire des Antiquités," and A. S. Georgiades' "Les ports de la Grèce dans l'Antiquité qui subsistent encore aujourd'hui," Athens, 1907. Further, two essays by J. Paris on the harbor works of Lechaeum (Corinth) and Delos may be mentioned, which have appeared in the *Bulletin de la Correspondance Héllenique*, Vol. 39, 1915, pp. 5–18, and Vol. 40, 1916, pp. 5–73, respectively. For the western Mediterranean only Carthage and a few of the ports of Italy have formed the subjects of special investigations. Only one fundamental study of Italian harbors has thus far appeared, published by the Italian Ministry of Marine:, "Monografia storica dei Porti dell'Antichita (I) nella Penisola Italiana," 1905, "(II) nell' Italia insulare," 1906. Two other works bearing on the engineering side of harbor works may also be noted: Merckel's "Die Ingenieurtechnik im Altertum," 1896, which attempts to sketch the entire field of harbor construction from the technical point of view, and Neuburger's "Die Technik des Altertums," 1919.

In this dearth of comprehensive treatises there was certainly a place for such a fundamental and complete work as the one under review. It is based on an exhaustive study of all the notices found in ancient literature and modern books concerned with the subject and the results of investigations. As the subject of ancient harbors is so immense, Dr. Lehmann-Hartleben has wisely confined himself to those of the Mediterranean and Black Seas—an area which formed in antiquity a geographical and historical unity (see Alfred Philippson: Das Mittelmeergebiet, 2nd edit., 1907). The port and its surroundings were regarded in antiquity as an integral part of the city much more than is the case today and more closely connected than any other branch of city building with the economic, political, and judicial conditions of the

city state. The problem of the author has been, in brief, to reconstruct the architectural appearance of ancient harbors—quays, moles, contiguous buildings, and areas—so far as the literary and monumental evidence warrants. Like the market place (cf. Wymer: Die Marktplatzanlagen der Griechen und Romer, Munich, 1916), the harbor was not only a useful but, especially in Hellenistic and Roman times, an ornamental feature of the city.

The book falls into two unequal portions. The larger (pp. 1–239) contains the historical and descriptive text, to which is added a catalogue (pp. 240–287), alphabetically arranged and accompanied by ancient and modern references, of the 303 harbors of the Mediterranean world which have been preserved or are known from literature. There are also two short excursuses, one of two pages on "Harbor Officials," the other of eight pages on the various Greek and Roman "Harbor Names." There is also a six-page index arranged in three columns.

The opening chapter of the text is concerned with the beginnings, the various settlements in the eastern Mediterranean during the second millennium before the Christian era and the early centuries of the first—the Minoan and Mycenaean epochs in Crete, the isles of the Aegean, and on the coasts of the mainland of Greece. Because of the condition of seafaring obtaining in the prehistoric period, a good illustration of which is afforded by Homer's description of the harbor of Phorcys (Odyssey, XIII, 96), harbors as yet showed no architectural arrangement of buildings. A short account of the Phoenician and Philistine ports and of those at the mouths of the Nile in Egypt follows. As for the western Mediterranean there were no harbors throughout the prehistoric period. The second chapter discusses the *emporion*, the extraterritorial space before the city and contiguous to the port for the use of merchants and seamen—its location and limits, origin, use, capacity, management, legal status, etc. Ruins of such *emporia*, which were essential and characteristic features of Greek city life from the earliest times onward, are found all around the littoral of the two seas from the Spanish coast in the west to the port of Olbia near the mouth of the Borysthenes in southern Russia in the east. These ruins show that the *emporion* generally lay outside the city wall (e. g. at Chalcis) but sometimes inside (e. g. Piraeus, where the limit stones are partly preserved), though always separated from the city proper.

Chapter 3 discusses harbor works of the archaic period, from the end of the eighth to the beginning of the fifth century before Christ, when the beginnings of artistic surroundings first appear. In Chapter 4 the *limen kleistos*, or enclosed harbor, i.e. the part inside the ring wall enclosed by it for the protection of shipping, is treated. Examples can be found from the archaic period on through the classical, Hellenistic, Roman, and Byzantine times, and thence through the Middle Ages and the mercantile hegemony of the Genoese and Venetians (the best example under the latter is the port of Naupactus) to the Renaissance. Forty-two cities possessing one or more of these enclosed ports are listed.

Chapters 5 and 6 describe the port works of the classical period of the fifth and fourth centuries before Christ, including the ship sheds (*neoria*), wharves, dockyards, *emporia*, etc., especially the large constructions at Syracuse, Carthage, Mytilene, Tyre, Corcyra, Salamis, Eretria, and Piraeus. The history, size, and appearance of the *neorion* are also discussed. Chapter 7 carries the subject into Hellenistic times, describing the ports of Heracleia and Amastris on the Pontus, and those of Carthage, Lechaeum, Delos, and above all Alexandria. For, unlike the conditions at Tyre, both tradition and the ruins make it possible to reconstruct a picture of the great harbor of Alexandria with all its essential features. The imposing works of the Imperial Roman period are treated in Chapter 8. A good deal of space is devoted to Augustus' work at Puteoli, the oldest Italian harbor of world importance, at Forum Julianum (Fréjus) in southern Gaul, Portus Julius (between Cape Misenum and Puteoli), Misenum, Ravenna, Narbo, Caesarea in Morocco, Caesarea in Palestine,

and Ephesus. The harbors of the later period were characterized more by their usefulness than by their architectural splendor.

The concluding chapter is an interesting account of monumental representations of harbor works on paintings and reliefs from the close of the Hellenistic period down into Imperial times.

WALTER WOODBURN HYDE

SUBTERRANEAN SHELTERS IN FRANCE

ADRIEN BLANCHET. **Les souterrains-refuges de la France: Contribution à l'histoire de l'habitation humaine.** iv and 341 pp.; diagrs., index. Auguste Picard, Paris, 1923. 9 x 6 inches.

Blanchet has studied subterranean passages and believes they belong to many periods from the Neolithic to modern times, that they were made often for habitation as well as for refuge and storage, and that no one hypothesis will by any means explain them all. A comparison of Blanchet's list with that issued by Adrien de Mortillet in 1908 shows that this study is far from finality. Blanchet claims in effect that these subterranean refuges are very unequally distributed and are most characteristic of Picardy and of some parts of the edge of the Plateau Central, as well as of the Vendean coast area.

Finds have not as yet greatly helped to analyze out types or to fix dates. Polished stone axes abound in these refuges, and some have been cleared out by these implements; metal is very rare; there is pottery of Neolithic and of most later varieties; coins of many periods occur but are rare. The Neolithic age of some of these refuges seems clear; but references in Caesar, in early Christian and medieval chronicles, and in the eighteenth century writings show that they remained in use though probably not continuously.

The author notes the frequent association of these passages with churches and evidently sees in this a proof of their importance in the Middle Ages. They exist under many French towns, according to the author, who thinks that cellars of private houses are often walled-off portions of old passages; among the towns he mentions are Arras, Béthune, Beauvais, Laon, Provins, Senlis, Paris (south), Chartres, Orleans, Bourges, Clermont-Ferrand, Limoges, Poitiers.

Numerous plates give examples of plans, and the author spends some pages on features he has found in various subterranean refuges. Special mention is made of roof forms, and the author evidently wonders whether the dome roof found in the center and south of France (Creuse, Haute Vienne, Dordogne, Tarn et Garonne, Charente-Inférieure) in some refuges is not the origin of the cupolas which are so characteristic of churches in this region (e. g. at Angoulême, Périgueux, and Cahors). He takes from Brutails (1900) the view that these cupolas are an autochthonous feature rather than the view that for some reason the Byzantine cupola took root here.

H. J. FLEURE

THE CANARY ISLANDS

D. A. BANNERMAN. **The Canary Islands, Their History, Natural History and Scenery: An Account of an Ornithologist's Camping Trips in the Archipelago.** xv and 365 pp.; maps, ills., index. Gurney & Jackson, London and Edinburgh. 1922. 9 x 6 ½ inches.

HERMAN KNOCHE. **Vagandi Mos: Reiseskizzen eines Botanikers. I. Die Kanarischen Inseln 1923.** 304 pp.; maps, ills., index. Librairie Istra, Strasbourg and Paris, n. d. 10 x 6 ½ inches.

David Bannerman, in his recountal of a series of visits made between 1908 and 1920, brings our information concerning the Canary Islands thoroughly up to date.

Geological evidence, he states, points to the fact that the Canaries are not the remaining peaks of either the mythical Atlantis or of a former continent which has sunk beneath the waves, but they have been built up by volcanic action, probably in the late Tertiary, upon the basis of a sunken oceanic continent, perhaps of the Paleozoic or early Mesozoic. The archipelago consists of a western group of five large islands and an eastern group, truly desert in character, of two large islands and six small, rocky islets.

The original inhabitants, the Guanches, were of two races, one related to the Arabs peopling the eastern islands; the other, related to the Berbers of North Africa, peopling the western group. The recently discovered Egerton manuscript, now in the British Museum, of much earlier date than those hitherto relied upon, gives the questionable honor of leadership of the European expedition which first exploited the gallant people and beautiful territory of the islands, to Gadifer de la Salle rather than to Jean de Bethencourt. Some interesting relics of the aborigenes still remain, notably the whistling language of Gomera, which, Mr. Bannerman urges, should be studied and preserved before it becomes extinct.

The discoverers found many goats on the islands. Today, in addition to the usual domesticated animals, the only small terrestrial mammals are rats, mice, hedgehogs, and rabbits, all of which have been introduced; but the hedgehog at so remote a date that it has become differentiated into a new race. Even the flea that infests it is a new species. Bats fly over from the mainland and have become specifically differentiated in the island of Palma. There is one small frog, a tree frog, three forms of skinks, two geckos, and several geographical races of lizards which show environmental differentiation similar to that of many of the birds, the most remarkable the giant lizard of Hierro, measuring nearly two feet. Snakes are unknown.

It is chiefly as an ornithologist that Mr. Bannerman writes, though along with his discussions of bird life he gives very many important data concerning the distribution and character of the native flora, which is intimately correlated with the fauna. Indeed, from the character of the plant zone, the species of bird inhabitants may be foretold, and endemic birds are continually found in association with endemic plants: for example, Bolle's pigeon became extinct in Gran Canaria when the Canary Laurel (*Laurus foetens*) was destroyed.

"The birds of the Canary archipelago," says the author, "are just such as we should expect to find inhabiting islands which have never been joined to the mainland and which have been compelled to rely on storms, regular migratory movements or successive invasions for their bird life." Long isolation has in many cases, resulted in the development of "environmental species." Both Darwinian selection and mutational evolution, Mr. Bannerman thinks, have been at work to produce the remarkable endemic Ornis. Of the 61 resident birds, 42 are endemic species or subspecies. In many cases each of the islands has its own peculiar race, distinct from the forms found on the neighboring islands.

Pope, the poet, deplores man's inhumanity to man: Dr. Knoche, the scientist, deplores man's inhumanity to Nature. The study of the plant life of the Canary Islands is a study of the ravages wrought by man in an earthly Paradise.

The islands are volcanic in origin, the whole group being dominated by the magnificent peak of Tenerife, which has an important influence in plant distribution. The archipelago lies in the path of an almost continuous, moisture-laden northeast wind, which envelops the higher levels of the five western islands in cloud. The moisture, condensing upon the forest foliage, falls to the ground in a ceaseless shower penetrating the soil more effectively than would a heavy rain. Hence the Spaniards in the fifteenth century found the islands clothed with verdure. Twenty-two species of the laurel group flourished in the forests. On the slopes of the gorges grew the native palm (*Phoenix canariensis*). In the zone above the laurels were forests of the tree heath (*Erica arborea*), the native holly (*Ilex canariensis*), *Myrica Faya*, and

species of Cistus. Still higher, sometimes reaching an altitude of 7000 feet, were extensive forests of the native pine (*Pinus canariensis*), juniper, and cedar. Along the coasts exposed to brilliant sunshine and arid winds, flourished Euphorbias (notably *Euphorbia canariensis*, the giant species resembling the cacti of our own west), many species of Sonchus, Senecio, hairy Leguminosae, and spiny Opuntias. The eastern islands are entirely desert, with interesting and peculiar desert flora.

With wonderful vigor and success and greatly aided by hordes of goats and rabbits which followed in their train, the discoverers undertook the work of plant extermination. By means of the ax and the torch the forests were rapidly destroyed, and the work of desolation continues even to the present day when the peasants scour the remote hillsides for the few remaining plants sufficiently large to be used as fuel. A few scattered groves of the great laurels and some remnants of pine forest have been spared either because they belong to species (*Ocotea*) whose wood is not useful, or because they are difficult of access.

Dr. Knoche spent six months on the islands studying the flora from the standpoint of the ecologist and endeavoring from data furnished by the presence of plants which invariably accompanied or succeeded the former forests to reconstruct the picture of the flora of the past. In connection with the discussion of each of the islands is given a map showing the groupings of the flora in the coast, laurel-forest, and pine-forest zones. The herbarium list at the close of the volume is supplied with line maps indicating the habitats of some of the most characteristic species. A large number of endemic species makes the archipelago peculiarly interesting to the student of plant geography, and it is to be regretted that the list does not differentiate these endemics from other species and that it does not give the geographical distribution of the plants found both on the island and elsewhere. The relationships of the flora are chiefly North African and Mediterranean, but an occasional species finds its nearest living kin in far distant regions of America or Europe.

Alice Carter Cook

Southern Rhodesia: A Pioneer Land

E. T. Jollie. **The Real Rhodesia.** xvi and 311 pp.; map, ills. Hutchinson & Co., London, 1924. 18s. 9 x 6 inches.

The pioneer belts of the world are of special interest to geographers because each one of them is a geographical laboratory. Man is there presented with a choice of alternatives—the land is new, shall the road or the railway run this way or that; is the soil suitable for the familiar crops of the colonist or are there native crops better adapted by centuries of trial to the special conditions of the region; the penny must do acrobatic feats and not merely lie in bank at four per cent. Appreciate the spirit of freedom and enterprise which the pioneer brings to his problem, and one is in the way of seeing how vastly important to the geographer are the marginal belts of desert, grassland, tundra, and forest where man ventures greatly under new and hard conditions to make a home in what the city dweller would call a wilderness. Mrs. Jollie's book deals with a pioneer land—Southern Rhodesia.

The position of Rhodesia is of first importance. It is back of Portuguese East Africa, and its nearest seaport is Beira on the eastern coast. Through it runs a section of the Cape-to-Cairo line. It takes 68 hours to go from Cape Town to Bulawayo on the southern border of the colony. It takes 20 hours to go from Bulawayo to Salisbury, the capital, and a similar journey takes one from Salisbury to Beira. There are a few branch railways to smaller towns and mining districts, but an immense amount of railway construction has still to be done to serve the colony adequately. The area of Southern Rhodesia is 149,000 square miles. Aside from its minerals, corn and cattle are the leading products. The agricultural and pastoral industries began seriously less than fifteen years ago, and they have made good

progress considering the problems to be solved. A number of agricultural companies have established branches and obtained their land on better terms than individual owners. There has been a considerable amount of speculation, as in all new countries. At the present time there are 230,000 acres of cultivated land in Southern Rhodesia, of which 80 per cent was devoted to "mealies" in 1921–1922. Maize as silage came next and then tobacco, other crops being ground nuts, roots, legumes, fodder, and a small amount of cotton. The sheep industry is only beginning. At the present stage of the pastoral industry the rank wild grass is burned every year to provide fresh growth for grazing. Rhodesia is understocked at present, for there is one beast to 52 acres, "although some land has been proved capable of carrying one beast to ten or twelve acres." While there is no compulsory labor the Native Commissioner sometimes has to be requested to "bring out the desired number of men." The native labor is supplemented by importations from the north.

The most important part of the book deals with the question of the land: its use by natives and whites, the pioneer conditions involving a knowledge of routes, the perpetual difficulties with which the settler has to contend, and degree and kind of support first from the British South Africa Company and the Imperial government and now from the local government, which became effective with the divorce of the British South Africa Company from its holdings in Southern Rhodesia. While the author is devoted to the cause of local responsible government and finds little to praise in the history of the commercial company and the actions of the Imperial government, it must be remembered after all that it was the company and not the settler that made the first organized venture into the territory. All this is now history. Southern Rhodesia is a Crown Colony, the annexation of the territory being announced by the British government on September 3, 1923. The British South Africa Company is now a private trading concern, and instead of having the broad privileges which it has enjoyed for 33 years it is now a company with limited privileges. There is a Governor appointed by the Crown and a Ministry and Legislative Council. The Company retains its mineral rights and the privately owned railways. In addition, it may be noted here that the Company's administration of Northern Rhodesia ended in 1924, and what possibilities there may be of the union of these two outlying countries it is yet too early to say.

Of value to the geographer are the sections dealing with native life and the mode of the control of the settler by the Resident Commissioner, who watches over the rights of the natives and without whose approval no legislation affecting the native can be passed. The white settler has a heavy responsibility with reference to the backward native, and he has also a distinctly selfish interest in the problem because native labor is his main source of power for the cultivation of his fields, the care of his cattle, and the working of his mines. About 20 per cent of the land of Rhodesia is set aside as native reserves. About 45 per cent is still unalienated. Almost all of the rest is held by individuals or companies for farming purposes, though only 57 per cent of that so held is actually occupied. The locked-up land includes some of the best in the country close to the railway, and the fact that it is held for speculation is a deterrent to immigration.

Forty Years of Madagascar

G. Grandidier. **Le Myre de Vilers, Duchesne, Gallieni: Quarante années de l'histoire de Madagascar, 1880–1920.** 252 pp.; maps, ills. Soc. d'Éditions Géographiques, Maritimes et Coloniales, Paris, 1923. 24 fr. 10 x 7 inches.

In this volume M. Grandidier recounts the events immediately preceding the French annexation of Madagascar and the history of the island under French administration. The narration is centered around the three chief French protago-

nists, M. Le Myre de Vilers, and Generals Duchesne and Gallieni. A geographical setting may be found in M. Grandidier's article "Madagascar" in the *Geographical Review*, Vol. 10, 1920, pp. 197–222.

Difficulties between the French and Malagasy governments led to the war of 1883–1885, which was concluded by a treaty establishing a French protectorate in 1886 with the appointment of Le Myre de Vilers as Resident. In spite of the conciliatory efforts of the Resident the situation remained unsatisfactory, and war broke out anew in 1895. General Duchesne assumed charge. In a few months peace was again concluded. Again insurrection followed. Madagascar was declared a French colony, and General Gallieni was despatched to the scene. Pacification started in earnest and was rapidly accomplished. In 1905 Gallieni wrote to the Minister of the Colonies: "The pacification of Madagascar being completed and the greatest difficulties to the construction of the railway from Tamatave to Tananarive being solved, the finances in a prosperous state, the work of administration, of education, and medical assistance giving satisfactory results, he considered his task at Madagascar finished." Progress has been continuous, and today Madagascar can be ranked definitely with the civilized nations.

Significance of the Flora of the Philippines

E. D. Merrill. **Distribution of the Dipterocarpaceae: Origin and Relationships of the Philippine Flora and Causes of the Differences between the Floras of Eastern and Western Malaysia.** Maps, ills. *Philippine Journ. of Sci.*, Vol. 23, 1923, pp. 1–33.

This is a very important paper for geographers, geologists, and biogeographers, because it correlates and interprets in a remarkable manner many diverse geographic influences. The dipterocarps are dominant forest trees in the vast Malaysian region at low altitudes in humid areas. The family is almost solely confined to India and Malaysia: of its 377 species belonging to 17 genera, all but 16 species are Indian or Malaysian. There are five regions of major development of these trees. The great center of their present abundance is in the Sunda Islands, including Sumatra, Java, Borneo, and smaller islands, which have 144 species belonging to 11 genera. A second center is in the Eastern Peninsula, including Assam, Burma, Siam, Indo-China, and south, and it has 135 species belonging to 11 genera. The next richest area is in the Philippines, with 50 species in 9 genera. Ceylon has 47 species in 10 genera. India proper has only 13 species in 6 genera; here settlement, as in Java, may account for the comparative scarcity of species. The attenuation of dipterocarps in Eastern Malaysia, beyond Wallace's line, is very striking, including only 14 species of 4 genera.

The general ecological characteristics of the family are thus summarized: "It is a peculiar biological character of this family that, with almost no exception, the numerous species are essentially confined to the primary forests. They do not thrive in the open country and are never components of young secondary forests or of forests that rapidly spring up in deforested areas that are allowed to revert from cultivation where grass fires are not a limiting factor . . . as much as seventy years may elapse before the trunk attains a diameter of 5 centimeters, although the rate of growth after this long suppression period is very rapid. It would seem that all or most dipterocarps have this adaptability to a long suppression period in early life; hence their ability to thrive in and eventually to dominate the dense primary forests of India and Malaysia. . . Generally speaking, the seeds of the dipterocarps are noted for their brief period of viability; they do not in general withstand drying out, which is perhaps one very potent reason for their practical nonoccurrence in open places . . . it becomes perfectly evident

that, in order to explain their present geographic distribution, it is absolutely necessary to postulate previous land connections from India to New Guinea."

The geological history is thus summarized: "We now know enough of the geological history of the Dipterocarpaceae to state definitely that this family was developed and widely distributed in India and Malaysia in late Tertiary times, and that it probably developed as a family in southern Asia and in what is now western Malaysia when the Sunda Islands were united with the Asiatic continent. It arose, perhaps, in the early Tertiary or in the late Mesozoic. So far as the Philippines is concerned, our Dipterocarpaceae reached the Archipelago during the Pliocene or earlier . . . The rate of dissemination of the dipterocarps is relatively slow, so that a long period must have elapsed during which land connection existed between the Philippines and western Malaysia, over which the trees migrated."

Geologists recognize that during the Tertiary, Java, Sumatra, Borneo, and New Guinea were forming marine sediments in shallow seas, which were alternately elevated and submerged. During the Pleistocene these islands were repeatedly connected with the Asiatic mainland, as New Guinea was with Australia. Formosa had a similar relation to Asia. During the Pleistocene, marine deeps and upthrust islands were formed. The Formosan Rift, between Formosa and the Philippines, probably originated in the Tertiary. Molengraaff's hydrographic studies of this whole region show that the 200-meter contour line roughly bounds the continental shelves.

Upon the basis of his faunal studies Wallace made the boundary between the Asiatic and Australian faunas come between Bali and Lombok and northward along Macassar Strait, which is now known as "Wallace's line." Later Pelseneer wished to move this boundary to the east of the Celebes and Timor and called the new one "Weber's line." Molengraaff's studies show that these two lines are the major boundaries between the Asiatic and the Australian continents and that the area between Wallace's and Weber's lines is the unstable tension zone, undergoing elevations and depressions between the two relatively stable continental masses since the Pleistocene and even earlier. Molengraaff considers Weber's line as the most important geological boundary in Malaysia; but biologically it seems to rank with Wallace's line, as Merrill well points out. The faunas and floras in this unstable area show various degrees of intermingling because of the varied opportunities afforded in this zone of maximum change. The biogeographical consequences of these relations are of the utmost importance, and reference is made by the author to both the zoölogical and botanical literature bearing upon this subject. The Pleistocene climate of the region is believed to be much like that of today, although the possibility of earlier local drier areas is suggested.

With this background we turn to an interpretation of the facts of distribution of the dipterocarps and of other flowering plants of the Philippines. Of the genera of flowering plants living in Western Malaysia, there are about 356 unknown east of Wallace's line; but 218 of these, or 61 per cent, are found in the Philippines. Of the Eastern Malaysian flora there are 225 genera that do not reach Western Malaysia, and of these 56, or about 25 per cent, reach the Philippines. Thus this flora is of mixed origin. The dipterocarps show a similar relation, indicating a prolonged land connection between the Philippines and Borneo, earlier than the connection between Mindanao, Celebes, and New Guinea. Many groups of animals harmonize with the flora in both its Asiatic and Australian affinities.

There are thus two major centers of origin and dispersal in Malaysia: (1) an Asiatic outlier, Sunda Land Center (Sumatra, Borneo, etc.), on the northwest on relatively stable land, which might well be called the Dipterocarp Center, and (2) to the southeast an outlier of the Australian continent, on New Guinea, also on relatively stable land, the Guinea Land Center, from which has radiated still other groups of plants and animals. In the region between these great centers lies a broad

belt, bounded by Wallace's and Weber's lines, including an area of archipelagoes, an unstable area which has undergone many changes, resulting in an extensive intermingling of the Asiatic and Australian flora and fauna. In conclusion it is worth mentioning that a somewhat similar region exists between North and South America and between Siberia and Alaska.

CHARLES C. ADAMS

ANTARCTIC PHYSIOGRAPHY

R. E. PRIESTLEY. **Physiography (Robertson Bay and Terra Nova Bay Regions).** x and 87 pp.; maps, ills., index. British (Terra Nova) Antarctic Expedition, 1910–1923. Harrison & Sons, Ltd., London, 1923. 7s. 6d. 12 x 9½ inches.

GRIFFITH TAYLOR. **The Physiography of the McMurdo Sound and Granite Harbour Region.** xvi and 246 pp.; maps, diagrs., ills., glossary and index. British Antarctic (Terra Nova) Expedition, 1910–1913. Harrison & Sons, Ltd., London, 1922. 12 x 9½ inches.

F. DEBENHAM. **The Physiography of the Ross Archipelago.** xiii and 40 pp.; maps, diagrs., ills. British (Terra Nova) Antarctic Expedition, 1910–1913. Harrison & Sons, Ltd., London, 1923. 5s. 12 x 9½ inches.

C. S. WRIGHT. **Physiography of the Beardmore Glacier Region.** vii and 25 pp.; map, diagrs., ills. British (Terra Nova) Antarctic Expedition, 1910–1913. Harrison & Sons, Ltd., London, 1923. 5s. 12 x 9½ inches.

The regions described stretch for about a thousand miles along the great fault zone that forms the eastern border of South Victoria Land. There are two areas of volcanic rocks, the largest extending for about two hundred and fifty miles from the northern end of the zone, and the area about Ross Island. They have been considered as related to the great tectonic movements that produced the faults. Debenham thinks the southern area had two principal vents in Mt. Erebus and Mt. Discovery and that cracks radiating from these centers gave rise to many subsidiary vents. He recognizes other minor vents that have entirely disappeared, probably by faulting. For instance, the small islands west of Ross Island are volcanic and indicate a vent in their neighborhood; but they are separated by water, one to two hundred fathoms deep, from each other and from Ross Island. Between the two volcanic areas, and farther south, granites predominate along the coast, with ancient schists a short distance inland. Still farther west the nearly horizontal Beacon sandstone covers an immense area, but it has disappeared from the coast.

Robertson Bay is at the northern end of our zone. It is about thirty miles wide and about as deep, and faces north. It is separated from Ross Sea on the east by a peninsula of volcanic rocks some three thousand feet high, which ends in Cape Adare. Great glaciers flow into it. On account of steep slopes and fierce winds the eastern side of the bay collects comparatively little snow, and great stretches of bare dark rock are exposed. The ends of the glaciers are free of snow. In strong contrast the western side is an area of calms and heavy snowfall, and the glaciers are entirely snow-covered. The topography is very confused and lends force to Priestley's suggestion that faulting here has taken place rather recently, when the glacial cycle was well advanced. Erratics were found imbedded in the volcanic flows of Cape Adare, showing strong glacierization before the upper flows occurred.

The main agents of erosion in the Antarctic are: sea waves, thaw and frost, wind, cirque nivation, and glacial abrasion. Their relative efficiency varies, of course, in different places. Cliffs are common along the coast and may be due to wave action or to frost at low levels, or even to faulting; for depths of several hundred fathoms occur not far from land. Cape Adare is the principal example of marine erosion; its eastern face has been cut back so far that it has encroached upon its

western slopes. Frost action is extremely effective; sunshine, through the clear air, warms the rock and melts the snow in contact with it, and the water freezes quickly when it passes into the shade, between the rocks or in cracks, so that almost all exposed surfaces are covered with broken and riven rocks, and many slopes consist of rock fragments at the angle of rest. True water erosion is slight, for the amount of water is small and it acts for too short a time. Wind carves the rock in fantastic shapes but has no effect on the general topography.

The important physiographic question is, of course, how was the topographic relief developed? And the authors are not in accord in their answers. Taylor notes that ground moraine is found generally in places abandoned by the glaciers, but its amount is small; and only two or three typical terminal moraines were seen. Few glacial striae were found except about Granite Harbour, and faceted spurs were not common. Cirques, however, were numerous at various altitudes over the whole region. These observations led him to the conclusion that there has been comparatively little glacial scour; and he proposes the "palimpsest" theory to account for the valleys. This assumes that several cirques were developed one behind the other and that they gradually deepened their beds by nivation, eating backward more than sideways until they became connected and formed a continuous valley, rising by steps. The parts between the original cirques would be less eroded and might later be worn down by glacial scour or might remain as rocky bars, or *riegel*, across the valley. Priestley discusses cirque erosion very carefully and shows, I think satisfactorily, that the cirques broaden their basins on all sides but can do little in the way of deepening them. Many of the pictures show saucer-shaped cirques filled with snow which have all the appearance of being shallow. The Terra Nova region is instructive. Several glaciers—the Priestley, the Corner, the Campbell, and its large tributary the Boomerang—unite to form the Priestley-Campbell Confluent Ice. This is a large floating mass, which differs from an ice tongue only in occupying a nearly landlocked bay. The valleys of the glaciers mentioned all follow contacts of the granite and the schists. One would expect, from the general relief, that the Campbell Glacier would flow down the steeper slopes directly to the sea, but it turns to the southwest and flows down gentler slopes to the Confluent Ice. Priestley thinks that these valleys may have been started by water erosion before the glacial advance and deepened by glacial scour. He thinks that the greater quantity of the ground moraines has been deposited under the sea and in confirmation notes that glacial drift has been brought up by dredges in many places.

Wright noticed a slight difference in the dip of the strata on opposite sides of the Beardmore Glacier and thought that this might indicate a fault. Priestley gives more attention to faulting but is cautious in ascribing too much to this process for lack of sufficient evidence. One cannot quarrel with this position; but it does not seem possible to explain the topography by stream erosion modified by glaciation, nor by any type of glacial erosion alone. The general tabular tops of the elevations, the irregular directions of the valleys, glacier troughs with one side smooth and the opposite side quite irregular, the fact that the region is one of recognized faulting, all suggest block faulting. Priestley thinks the great bay occupied by the Priestley-Campbell Confluent Ice is a tectonic basin, as it seems to be too large to have been cut out by the glaciers that feed into it.

Taylor is puzzled by the absence of moraine covering the ends of the glaciers, which is so characteristic of many Swiss and New Zealand glaciers. But glaciers whose upper reservoirs are not dominated by cliffs have no such covering in Switzerland or elsewhere. Near Cape Royds, on the western side of Ross Island, ice filled with rocks projected below the apparent end of the Erebus Glacier. The rock was so abundant that it was difficult to tell where the glacier ended and the moraine began. This was called the "Ramp." May it not be due to material ejected from

Mt. Erebus, which fell on the upper reaches of the glacier and was carried down to the end? and does it not represent the material that would cover the end of a temperate glacier?

Priestley describes some small lakes on the Corner Glacier, which had dissolved salts from the rock and had become so concentrated that salts were precipitated to the bottom; and he suggests that this is a "possible clue to some of the occurrences" of mirabilite, which Debenham had supposed came up through the floating ice by continual freezing at the bottom and ablation at the top. Priestley's suggestion is much the more acceptable.

The land seems to have been depressed some five hundred feet in the not distant past and very recently to have been elevated about fifty feet, at least in places. Taylor thinks the depression is merely an elevation of the sea by water derived from the diminishing ice covering of the Antarctic continent. Priestley thinks the recent elevation is due to the adjustment of isostatic equilibrium after the same change.

The authors have collected a great number of most interesting observations and deserve our congratulations for accomplishing so much under extraordinarily difficult conditions.

Harry Fielding Reid

The Romance of Exploration

John Buchan. **The Last Secrets: The Final Mysteries of Exploration.** 303 pp.; maps, ills. Thomas Nelson & Sons, London, 1923. 7½ x 5½ inches.

The lament is often heard that the romance of exploration is a thing of the past. As the network of explorers' routes becomes an ever finer mesh and the unknown patches of the earth's surface diminish in number and in size, "the morning freshness has gone out of the business, and we are left with the plodding duties of the afternoon." Thus Mr. Buchan. Yet why should the mere fact that some previous Occidental traveler has traversed a given region and has mapped and written about it necessarily "de-romanticize" the region for all explorers who follow after? The pioneer explorer, after all, makes the merest beginning. A larger view of the purpose and scope of exploration teaches us that we are far from having revealed "the last secrets" or from having torn the veil from "the final mysteries of exploration."

However this may be, Mr. Buchan's book is an absorbing one. Its purpose is to relate for the popular reader in a graphic and colorful manner some of the more adventuresome journeys of the first two decades of the twentieth century. The topics selected fall in widely scattered areas, chosen to illustrate the problems of exploration under divergent conditions of climate, relief, and vegetation. The selection is on the whole well made, though much more attention is directed to British and American travelers than to those of other nationalities. A book of the same type by a continental European would unquestionably give a very different orientation. The French, for instance, would regard some of their work in the western Sudan and in equatorial Africa as equally worthy of record as the explorations of the Brahmaputra gorges. We also cannot help regretting that no mention is made of Stefansson's methods of Arctic travel.

Three chapters are devoted to Himalayan regions, more specifically to Younghusband's expedition to Lhasa, to the work of Bailey and Morshead in the gorges of the Tsangpo-Brahmaputra, and to the Mt. Everest parties of 1921 and 1922. The extraordinary contrasts between mountaineering in the tropical and sub-Arctic zones are brought out in chapters dealing with the Duke of the Abruzzi's survey of Ruwenzori and with Parker and Browne's ascent of Mt. McKinley. The two chapters on the North and South Poles, each introduced by a brief outline of polar exploration in earlier times, conclude with sketches of the voyages of

Peary, Scott, and Amundsen. Nothing could be more unlike the problems encountered by travelers in the Arctic and Antarctic than those which confronted Rawling and Staniforth Smith in the rain-drenched jungles of New Guinea. A chapter devoted to Wavell's pilgrimage to Mecca and Medina in 1908–1909, even though not an account of pioneer exploration in the strictest sense, deserves its place in Mr. Buchan's volume because it is the story of one of the most audacious and thrilling journeys of modern times.

An American School Atlas

J. P. Goode. **Goode's School Atlas, Physical, Political, and Economic, for American Schools and Colleges.** xii and 96 (maps) and 41 (index) pp. Rand McNally & Co., Chicago, New York, 1923. $4.00. 11½ x 9½ inches.

Three of the maps in this atlas seem to me very fine—a most welcome advance on any maps of the United States that I know. They are the three sheets at pages 44 to 47, covering part of the northeastern and the Pacific States of the United States on the scale 1 : 4,000,000.

These three maps are pleasing in general appearance, and the colors are clear, transparent, and harmonious, expressing the relief of the country most admirably. The selection of cities is good, showing intelligence and restraint. There is no crowding with unimportant detail. Very effective is the picking out of the larger cities with red, in the best European style, though it might well have been extended to all cities of over a hundred thousand inhabitants, a figure which usage is beginning to accept as constituting a great city. Even in the northeast sheet that would have added only sixteen cities to those already marked out. The railways are successfully shown in thin red lines, which conceal nothing on the map and represent the main communications adequately. Except for faulty color registration—which can and should be remedied by throwing out badly printed sheets—the map is so good that the publishers ought to complete it and offer it to our schools as a wall study map. It would deserve use in every schoolhouse in the country.

There are some 25 other maps among the 300 odd in the book that have a good deal of the merit of these three sheets: Alaska (pp. 22–23), Canada (pp. 26–27), United States (pp. 30–31), Middle America (pp. 50–51), Great Britain, Ireland, and North Sea Lands (pp. 66–67), France (pp. 70–71), Middle Europe (pp. 74–75), Southern Japan (p. 81), China and Japan (pp. 82–83), Levant, Arabia, Persia, and India (pp. 84–85), Indo-China and East Indies (pp. 86–87), and Australia (pp. 90–91) are the best. This group of 28 maps is a welcome addition to the material available in American schools, and it covers the 40 pages that give value to the present book. I am glad to see included Shantz and Zon's admirable vegetation map of the United States and Marbut's soil map, though the colors are very trying and the registration bad.

The small maps that make up the bulk of the book are not so good. Undoubtedly many of them will be found useful, and some of them have never before appeared in such a collection. The colors are unattractive, there being too many large patches of an ugly red. The maps are roughly drawn. Much neater are the similar maps obtainable in lower-priced English publications. Only moderate accuracy, I suppose, is to be expected on maps drawn without co-ordinates; but that cannot justify showing on-shore winds on the coast of northern Chile (p. 52). The charts of the Pacific Ocean of the Hamburg Marine Observatory leave no doubt on that point, which happens to be so important as to govern the whole economic life of the region. I should not think of consulting any of these diagrams for the climatic or economic data they tell about rather than record. In this part of the book the publishers have not risen to their opportunity. I should have liked to see Kincer's superb rainfall map of the United States get more adequate reproduction than the indifferent

little map on page 33. Human data belong on the map, and it deserves a larger scale. But it typifies the book's treatment of climatic and economic data. Even for its scale it is not a good reproduction of the original. Rainfall maps are rather unsympathetically treated in all parts of the book.

The abridged edition costs half as much as the larger work; but, as it contains none of the maps here spoken of as best and only three of the twenty-eight called fine, the larger book is much the better bargain. There will not be much rivalry with this book. I know of no other American school atlas. The best part of the book is very creditable to American map making.

MARK JEFFERSON

Ancient Cartography

KONSTANTIN CEBRIAN. **Geschichte der Kartographie: Ein Beitrag zur Entwicklung des Kartenbildes und Kartenwesens. I. Altertum. 1. Von den ersten Versuchen der Länderabbildung bis auf Marinos und Ptolemaios (zur Alexandrinischen Schule).** Mit einem Anhang "Ptolemaios als Kartograph," by Joseph Fischer. 129 pp.; maps, diagrs. (Geogr. Bausteine, No. 10.) Justus Perthes, Gotha, 1923. 8½ x 5½ inches.

As explained in the preface to this small volume, dated "Spring, 1914," the author's intention was to prepare a general history of cartography not only in its mathematical aspects but in its broader relations to the history of civilization. Cebrian was killed in the World War, and publication of the present part of the work—evidently the only part that was completed—was delayed.

Based upon researches carried out more than a decade ago, the volume is insufficient in many points of detail. Most of its larger conclusions, however, are probably sound. The writer lays especial stress upon the gradual evolution of cartography. The art of map making did not originate in the extensive movements of primitive peoples on the earth's surface. The Egyptian conqueror, the Phoenician trader, the Mongol horde, it would seem, were well able to find their way without the use of maps. Early cartography was, rather, an intensive growth among peoples of sedentary civilization. At first, as with the Egyptians, Hebrews, and Mesopotamian peoples, it was wholly practical: the maps of these folk were in the nature of cadastral plans, real-estate plots, specifications for the construction of temples, palaces, canals, and other engineering enterprises. They were not true topographical maps but diagrams designed to represent the sort of thing we now show on the architect's or engineer's blueprint. Greek genius, on the other hand, characteristically dealt not only with the practical but with the speculative; and among the Greeks pure, as distinguished from applied, science first made its appearance. As an outgrowth of these interests came the first attempts at the making of maps of large areas and the first experiments in the representation of the entire earth's surface upon a plane.

Cebrian based his outline of Greek cartography very largely upon Hugo Berger's "Geschichte der Wissenschaftlichen Erdkunde der Griechen," 2nd edit., Leipzig, 1903, a work which is now twenty years out of date. Cebrian's treatment of Eratosthenes and Ptolemy is therefore wholly inadequate in the light of more recent investigations.

The Bearing of New Data upon the Shape of the Earth

WALTER D. LAMBERT. **Effect of Variations in the Assumed Figure of the Earth on the Mapping of a Large Area.** *U. S. Coast and Geodetic Survey Serial No. 258.* iii and 35 pp. Washington, 1924.

It is not feasible for practical purposes to await the accumulation of complete data in order to obtain the theoretically best mean figure of the earth. The prac-

tice has been to use the best available data at certain epochs to derive the dimensions of a spheroid to be accepted for an indefinite period or until additional data might provide better values. A number of attempts have been made in this way to determine the mean figure of the earth; but only a few of the derived spheroids have actually been used for geographic purposes. A table on page 1 of this publication gives the principal determinations of the earth's mean figure. The Clarke spheroid of 1866 has been officially adopted by the whole of North America, and all of the geographic positions and azimuths derived from triangulation in the United States have been computed on the basis of this spheroid. Since this spheroid has been in use for a number of years and many data have accumulated in the meantime, the author has studied the probable bearing of these new data upon the following questions: (1) How much might the best obtainable spheroid for the earth as a whole differ from the Clarke spheroid of 1866, now officially adopted for the whole of North America? (2) How much difference would the adoption of such a spheroid make in the geographic co-ordinates of points now referred to the Clarke spheroid? (3) Is it probable that in the immediate future it will be necessary or desirable to give up the Clarke spheroid for geographic purposes and to adopt some other? (4) Are present methods of adjusting triangulation for obtaining the figure of the earth and the deflections of the vertical adequate when extended to a territory as large as the whole of North America?

The Hayford spheroid of 1909 is believed to be the best. This spheroid has a semimajor axis of 6478.388 kilometers, which is 182 meters larger than the Clarke 1866 value. While the effect upon the geographic co-ordinates due to changing from the Clarke spheroid of 1866 to the theoretically best spheroid would be small, it would not be negligible. It is probable that, if at any time the question of changing spheroids should be seriously considered, the economic aspect would be the deciding factor. The labor of changing from one spheroid to another is considerable. All the geographic positions and azimuths must be recalculated. About 20,000 geographic positions depending upon triangulation have been published by the U. S. Coast and Geodetic Survey, and about 13,000 more have been computed and are awaiting publication. Other government bureaus have also published a great many geographic positions on the North American Datum. All these would be invalidated by a change of spheroid, and the existence of two different sets of co-ordinates for the same point, one set on the old spheroid and one on the new, would inevitably lead to inconvenience, inconsistency, and confusion. Furthermore, it would be necessary to redraw the network of meridians and parallels on published maps or to renumber them, giving to the meridians and parallels, as at present drawn, a number that would be no longer a round number of degrees or of degrees and minutes but one ending in some odd number of seconds. This has been done before on some of the old Coast and Geodetic Survey charts, but it is an unpleasing and unsatisfactory expedient.

H. G. Avers

Animal Life in Deserts

P. A. Buxton. **Animal Life in Deserts: A Study of the Fauna in Relation to the Environment.** xv and 176 pp.; diagrs., ills., index. Edward Arnold & Co., London, 1923. 10s., 6d. 9 x 6 inches.

This book opens up a fascinating realm on the border between geography and ecology and suggests how much ecologists have to offer geographers towards the interpretation of the distribution of forms of life. Geographers are also to be congratulated when the material offered by workers in a contributory field is presented as pleasingly and as convincingly as Mr. Buxton has here presented it.

Mr. Buxton regards the environment of the desert as "an environment unspoilt by the hand of man so that one can more clearly observe [in deserts than elsewhere]

the interaction of plant and animal upon each other, and the dependence of the living creatures upon climate and other physical conditions." This subject is a fresh one, and Mr. Buxton makes no claim to having exhausted it. Though avowedly preliminary and suggestive, his book is nevertheless based upon sufficiently extended observations in the field and upon sufficient familiarity with the "literature" to render it a substantial contribution to our knowledge of the waste places of the earth. Since the volume is intended for the average, as well as the scientific, reader, the author is perhaps justified in omitting footnotes; but we cannot help regretting the omission of a selected bibliography or, at least, of references to the works of the various authorities so tantalizingly mentioned in the text.

The first two chapters give a clear account of the elements of desert climate, soil, and flora that exert the most powerful influence on animal life. The remainder of the book deals with the relations of animal life to the desert environment as a whole and to the component elements of this environment taken individually. The volume concludes with a discussion of the coloration of desert animals.

Mr. Buxton defines a desert as a place "in which the climate is hostile to animals and plants, in which normal agriculture is impossible, and in which nearly all the existent forms of animal and plant life are modified to endure life in their peculiar environment." The polar regions come within this definition, but Mr. Buxton's studies are devoted exclusively to warm deserts, particularly those of the Near East. Though climatic hostility to plant and animal life in warm deserts is normally manifested in scanty rainfall with marked diurnal and seasonal changes of temperature and in extremes of dryness and evaporation, Mr. Buxton believes that even more restrictive of the development of plants and animals are the aberrations of the climate, which are fully as characteristic: "long droughts, torrential rains, unusual frosts, violent whirlwinds."

The adjustments of living creatures to the component elements of the desert environment are many and varied. Adjustments, for instance, to scantiness of water offer particularly interesting examples of physiological adaptation. Most animals of the desert require little water. Camels have been known to go two months without drinking. Some animals never drink but obtain their water exclusively from the vegetation or from other animals. Subterranean rodents find moisture in the bulbs and roots of perennial plants, and the sparse but succulent, thick-leaved growths characteristic of the desert's surface are often miniature reservoirs. Experiments carried out by Mr. Buxton since the publication of his book have shown that even the dry fragments of vegetation blown about by the winds contain moisture upon which insects and small animals may thrive. These dry stalks are capable of absorbing water directly from the atmosphere when, as is often the case in the desert at night, the relative humidity rises above 80. (See P. A. Buxton: Heat, Moisture, and Animal Life in Deserts, *Proc. Royal Soc.*, No. B673, Ser. B, Vol. 96, 1924, pp. 123–131.) It is a well-known fact that camels when they can obtain abundant grazing hold out much longer without drinking than when the grazing is scarce and poor.

Many of the animals of the desert avoid the intense heat of the daytime by burrowing to cool, moist depths and die when exposed to the sunlight or superheated sand, rock, or gravel of the surface. (For the results of important observations of surface temperature in the desert see the article cited in the preceding paragraph.) The growth of desert plants and the nesting places of desert birds are often governed by the winds; some birds build nests on the windward sides of rocks or other objects to avoid being buried by sand as they would be on the leeward side. Of all desert soils, sand is the most inhospitable to animal life. Mr. Buxton has observed and sketched some remarkable scaly modifications of the feet of lizards intended to enable them to walk on shifting dunes.

In the concluding chapter Mr. Buxton shows that nearly all the creatures of the

desert are characterized by similar coloration and that this coloration corresponds notably with the colors of the desert itself. Pale buffs and sandy tones predominate. An explanation frequently made of this coloration is that it is protective. Mr. Buxton, however, believes that this facile explanation will hold water only in exceptional cases. Marshaling some strong arguments against the theory, he sums them up as follows: "It is not easy to apply [the theory of protective coloration] to animals which hunt or are hunted at night; or to animals which appear to be without any large enemies more powerful than themselves, or to animals whose pallid color extends to their bellies and the soles of their feet. It cannot be applied at all to subterranean animals . . . nor to those whose color would protect them if their habits were radically altered." Though Mr. Buxton frankly admits that he is at a loss to explain the "remarkable general depigmentation" of desert animals and the remarkable similarity of their colors to those of their surroundings, he believes that the explanation will ultimately be found on further investigation into the "effects of physical conditions upon the animal life."

The Lakes of the Earth

Wilhelm Halbfass. **Die Seen der Erde: Morphometrie derjenigen mindestens ein Quadratkilometer grossen Seen, für welche gesicherte Tiefenangaben vorliegen, nebst den Versuch einer Zusammenstellung unserer sonstigen Kenntnisse über die Seen der Erde, mit besonderer Berücksichtigung der wichtigsten unter ihnen.** vi and 169 pp.; bibliogr., index. *Petermanns Mitt. Ergänzungsheft No. 185*, 1922.

Wilhelm Halbfass. **Grundzüge einer vergleichenden Seenkunde.** viii and 354 pp.; maps, diagrs., ills., index. Gebruder Borntraeger, Berlin, 1923. 10 x 7 inches.

In the first part of "Die Seen der Erde" the author gives, in tabular form, the more salient facts regarding 1760 lakes having an area of one square kilometer or more. The different continents are represented as follows: Africa 27 lakes, America 172, Asia 100, Australia 29, and Europe 1432. The small representation of all continents except Europe is not due to the scarcity of lakes on the other continents but to a lack of information regarding them. The following items are given for each of the lakes listed in the table: latitude, river basin, elevation above sea level, area, maximum and mean depths, volume, circumference, number of soundings, and references to literature.

The second part of the paper contains descriptions of some of the larger lakes, such as the Great Lakes, Tanganyika, Victoria, Baikal, Ladoga, Como, etc., with further references to the literature. The third part consists of ten tables in which the more important lakes are classified on the basis of (1) area, (2) maximum depth, (3) mean depth, (4) volume, (5) length of shore line, etc.

The volume "Grundzüge einer vergleichenden Seenkunde" deals with the geology, physics, chemistry, and anthropogeography of the more important lakes of the earth. The Aral, Black, Caspian, Dead, and Red seas are taken into consideration also. Such a large and varied amount of information concerning lakes is included by the author that only the more general topics can be indicated in this brief review.

Following the introduction, which deals chiefly with the instruments and methods of lake investigations, the distribution of lakes in arid regions, in glaciated areas, in rock areas, in plains, in volcanic areas, and in alpine regions is discussed.

The next chapter deals with the history of lakes; that is the ways in which the basins were formed, the various modifications of the basins, and their final extinction. Under the subject of morphology, the shore-line development, the slope of

the bottom, the insulosity, the relative location of the deepest water, shore and bottom modifications, and the chemical composition of the bottom are discussed. The section on hydrology treats of changes in surface level, and the one on hydraulics considers seiches and currents.

Lake temperatures are given full consideration, because Professor Halbfass is interested chiefly in this phase of limnology. The absorption of the sun's energy by lake waters, thermal stratification, temperature seiches, freezing in winter, and the heat budgets of lakes are discussed in a very able manner.

The chapter on optics discusses the transparency of lake waters, the depth to which light penetrates, reflection, refraction, and color. This is followed by a short chapter on acoustics.

The chemistry of lake waters is presented in considerable detail. The salts in solution are considered first, and several tables are given showing the mineral constituents found in various lake waters. The dissolved oxygen and carbon dioxide are discussed in the latter part of this chapter.

In the section devoted to anthropogeography the author discusses the location of cities on the shores of lakes, lake fisheries, lake commerce, the importance of lakes as reservoirs in preventing serious floods, and their importance as sources of drinking water.

Many references to original literature are given in the notes appended to the various chapters. The book is a valuable contribution to limnology.

C. Juday

Two Introductions to Oceanography

Sir William A. Herdman. **Founders of Oceanography and Their Work: An Introduction to the Science of the Sea.** xii and 340 pp.; maps, diagrs., ills., index. Edward Arnold and Co., London, 1923. 21 s. 9 x 6 inches.

James Johnstone. **An Introduction to Oceanography: With Special Reference to Geography and Geophysics.** xii and 351 pp.; maps, diagrs., ills., bibliogr., index. University Press of Liverpool; Hodder and Stoughton, London, 1923. 8½ x 5½ inches.

These two introductions to oceanography, or the science of the sea, illustrate well the two viewpoints from which oceanography is regarded. On the one hand is the marine biologist—to whom a very considerable part of the recent development of oceanography is due—who is inclined to regard oceanography as a domain of science in which marine biology and its problems occupy a focal position. On the other hand is the oceanographer to whom oceanography is a branch of physical geography, with a distinct viewpoint of its own, whose broad demesne towards its outer boundaries overlaps those of a number of other sciences, among which may be mentioned astronomy, physics, chemistry, and biology. Sir William Herdman's volume presents the viewpoint of the marine biologist, while Dr. Johnstone's presents that of the physical geographer. And it is of interest to note that Sir William was the first occupant of the chair of oceanography in the University of Liverpool, being followed by Dr. Johnstone, the present incumbent.

In the preface to "Founders of Oceanography" Sir William states that it is not intended as a textbook of oceanography, being based on a course of public lectures given during his tenancy of the chair of oceanography in 1919–1920, the purpose of which "was to put before my colleagues and students what I regarded as the scope and nature of this new university subject." After an introductory chapter dealing with the earliest founders of oceanography, the following six chapters are devoted to sympathetic sketches of the lives and scientific work of some half dozen oceanographers of the past century—Edward Forbes, Wyville Thomson, John Murray, Louis and Alexander Agassiz, the Prince of Monaco, and Anton Dohrn. Incidentally

it is to be noted that these pioneers were primarily marine biologists. This explains the bare mention given to the American oceanographer M. F. Maury, generally acknowledged the founder of modern oceanography; and it explains, too, the statement (p. 41) that Wyville Thomson's great work "The Depths of the Sea," published in 1873, "may be regarded as the first general textbook of oceanography," whereas Maury's "Physical Geography of the Sea" appeared eighteen years previously. Following these biographical chapters comes the more formal presentation of the subject matter of oceanography, comprising chapters on hydrography, ocean currents, submarine deposits, coral reefs, luminescence in the sea, and plankton. This in turn is followed by chapters on aquiculture, the sea fisheries, and food matters in the sea. An appendix of six pages, reprinted from the *Report of the Council of the British Association for the Advancement of Science* for 1920–1921, gives a memorandum drawn up by a committee of the British Association on the proposed new *Challenger*, or national expedition for the exploration of the sea.

Sir William states that in the chapters devoted to the subject matter of oceanography he had deliberately limited himself to those matters in which he was most interested. There can therefore be no criticism on the score that the matters treated are principally those of a biological nature. One may, nevertheless, question the brusqueness with which, after one short paragraph, the tides are swept aside with the statement that "further details are more a matter for the astronomer than the oceanographer." This is the more surprising since in a previous chapter the author indicates the comprehensive nature of oceanography by dividing it into "Hydrography, Metabolism, Bionomics, and Tidology." The volume leaves untouched large areas within the field of oceanography; it is, however, so engagingly written that it furnishes an introduction to the science of the sea that is sure to be read with both pleasure and profit.

Dr. Johnstone's volume is a more formal introduction to oceanography. Realizing that "there is hardly any limit to the amount of descriptive detail that might be given" the author has attempted "to deal in a general way with the science of oceanography," having in mind, however, the student of geography and geology. He realizes the intimate relationship between oceanography and marine biology but confines oceanography to include only the physical part of the science of the sea, leaving the biological side to hydrobiology. In so doing Dr. Johnstone is undoubtedly expressing the convictions of the majority of oceanographers.

The scope of the volume is defined by the chapter headings. The first three chapters are devoted to the world ocean, the origin of the oceans, and the depths of the ocean. The following seven chapters then deal in order with the sea bottom, the oceanic margins, the chemistry of sea water, the physical characteristics of sea water, the tides, oceanic circulation, and secular changes in the ocean. Throughout, the subject matter is treated from the geophysical viewpoint.

In the reviewer's opinion, Dr. Johnstone has succeeded in producing an introduction to oceanography that will fill a long-felt want. He has succeeded in the difficult task of giving unity to the subject matter of oceanography.

H. A. Marmer

Power from the Tides

Norman Davey. **Studies in Tidal Power.** xiii and 255 pp.; maps, diagrs., ills., index. Constable Co. Ltd., London, 1923. 10 x 7½ inches.

In a very small way the energy of the tide has been utilized in various places for many years. A tide mill in England which was installed in 1790 is reported as still in operation. But it is only since the development, in recent years, of large hydroelectric power stations that large-scale projects for harnessing the tides have been seriously proposed. In Europe careful consideration is being given the matter. The

French Government has provided funds for the construction of a tidal power station of experimental type, and in England consideration has been given to tidal power schemes involving the estuary of the Severn.

The volume under review is a clear exposition of the problems involved in the development of power from the tides and within the compass of ten chapters deals with the matter in considerable detail. The introductory chapter is devoted to a brief consideration of the four systems that have been proposed for tidal power development, and the following chapter discusses the tidal phenomenon. After showing that the float system, the tidal stream system and the compressed air system have but little practical value, the author concerns himself with the tidal basin system which alone permits of large-scale installations. The various schemes of operation that may be used with the basin system are then reviewed in the two following chapters, both from the theoretical and practical standpoints, following which is a chapter devoted to the question of storage necessitated by the fact that tidal power is inherently variable.

Chapter 6 is of particular interest to the geographer in that it gives a tidal power survey of the world in general and of the British Isles in particular. It is to be kept in mind that the tidal power available per unit area of water surface varies as the *square* of the range of the tide. Hence while the practicability of tidal power development at any particular place will depend on local conditions, as a general rule the author holds that the exploitation of power from the tides is economically impracticable in regions having a tidal range less than 10 feet. Over the entire world there are only 15 areas in which the average range of the tide exceeds 20 feet; and of these, omitting localities remote from centers of population, there remain: the Bay of Fundy in America, France and England in Europe, the mouth of the Tsien-tang Kiang and the Sam Sa Inlet in China, and the Gulf of Cambay in India. Mr. Davey goes on to state that "It seems, as it were, a dispensation of Providence that that country which, in inland water power, is most poorly equipped—namely, England, with only 0.02 b.h.p. per capita available—should be third in strength of tidal power, and France, which is also poorly off with 0.14 b.h.p. per capita, second in tidal power; whilst countries like Norway, with 2.3 b.h.p. per capita of inland water power, possess tides of negligible range."

The last four chapters deal with the details, engineering and financial, of tidal power plants as they relate to conditions in Great Britain and with the industries to which cheap intermittent tidal power might be successfully applied. In conclusion the author states that "there is a very real difficulty in the economic exploitation of the power of the tides in respect to the many vested interests affected" and recalls that in Great Britain at the time of railway development the "compensation for affected injury to vested interests has laid a financial burden upon the railways which remains to this day." In his opinion "Government action, under wide discretionary powers, seems to be necessitated."

H. A. MARMER

THE COASTAL ZONE OF PERU

R. C. MURPHY. **Bird Islands of Peru: The Record of a Sojourn on the West Coast.** xx and 362 pp.; maps, diagrs., ills., bibliogr., index. G. P. Putnam's Sons, New York and London, 1925. 9½ x 6½ inches.

It was one of the favorite themes of the older biologists that all life arose out of the sea and that the creatures of the air and the land are in evolutionary descent from the cold-blooded marine types of a primitive world. Whatever modifications this idea may have had in the studies of our time, it is still true that the strand line, or, better still, the shore belt, is of extraordinary interest for life of all varieties. The

environment is here so varied that not only have strange forms arisen but the relationship of those forms is a matter of deep concern to the biologist and the geographer, as well as to the geologist. The scientific memoirs of outstanding merit in the South American field have dealt mostly with the land areas of that continent or with the environment of river and lake, mountain and plain. Some of the great scientific expeditions of the past, such as that of the *Beagle*, with which Darwin's name is associated, or the Wilkes expedition, of which Professor J. D. Dana was a member, dealt with the coastal belt in some degree; and of papers there are not a few that deal with the currents offshore and to a limited extent with their life. Mr. Murphy has followed the happy plan of combining the physical facts of the land and the sea in the coastal belt and of showing their relationship to life. As a specialist in ornithology his book is of course chiefly concerned with the birds and among these more particularly the guano-producing birds of the coast of Peru and the guano islands, such as the Lobos Islands and the Chincha Islands.

Mr. Murphy has done the task exceedingly well, writing in an easy, natural style that has the two outstanding qualities of clearness and sincerity. He writes as a scientist, not as an adventurer, and if there is a thrill here and there it springs from a real source and not from the mere technique of writing. Some of the chapters have appeared in scientific journals during the past few years, and the greater part of the book was originally published in the *Brooklyn Museum Quarterly* during the years 1920 to 1922. One of the longest chapters deals with the Humboldt Current and was originally published in the *Geographical Review* for January, 1923. Other chapters carry a goodly quantity of geographical material, particularly the chapter on Peruvian fisheries and that on the production of guano. The zoögeographical sections deal in a classic manner with the conditions of life and the interplay of living forms. No book on the subject has yet appeared which discusses in so attractive and authoritative a manner a part of the South American littoral. Nor could the author have chosen a better field, for the Humboldt Current here brings Antarctic conditions well toward the equator. Penguins in Peru and seals in the north Chilean harbors are no more strange than the anomalous temperatures that prevail all the way to the equator and that give the entire coast, especially in low latitudes, an extraordinarily interesting quality.

THE GEOGRAPHICAL REVIEW

VOL. XV APRIL, 1925 No. 2

LOOKING BACK AT MALTHUS*

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A fondness for poring over census figures that has lasted now for a quarter century has given me somewhat definite impressions of the trends of population growth.

Most census counts, as it happens, began with the nineteenth century. Sweden and Finland made their start in the middle of the eighteenth century, and Denmark, Norway, and Spain followed within twenty years (see Table I). Possibly we flatter ourselves when we indulge the notion that the United States fixed the practice. To set up the representative government that we had in mind it was necessary to count the people to be represented and to repeat the count at regular intervals. We have done it every ten years since 1790, the Civil War having come conveniently between census dates, though Reconstruction seriously vitiated the count in the South for 1870.

Whatever influence we may have had on others, most civilized countries soon began to count their people and have kept it up more or less regularly ever since. One may assert that the habit of regular census taking has become a sort of earmark of progressive and well-managed countries. Many countries, of course, are quite uncounted today. We do not know how many people there are in the world.

TRENDS OF POPULATION GROWTH

The simplest way to show the trends of population growth in the best-counted western countries is to set forth their annual percentage of increase through the century (see Table II). These 273 million people are believed to be about a sixth of the inhabitants of the world—the only people who have been counted through a whole century. The countries are not of equal weight statistically, as the present numbers in the last column show.

*Read at the Annual Meeting of the Association of American Geographers, Washington, D. C., Dec. 30, 1924–Jan. 1, 1925.

The first four countries include eight times as many people as the last five. Moreover, the United States has received 33 millions of immigrants that these and other European nations have lost and therefore shows migrational as well as biologic growth.

Table I—Earliest Census Dates and Numbers of Enumerations for European Countries*

Date	Country	Number of Enumerations	Date	Country	Number of Enumerations	Date	Country	Number of Enumerations
1749	Sweden . . .	34	1810	Prussia . .	30	1846	Belgium	9
1751	Finland . . .	29	1818	Bavaria . .	25	1850	Hungary	11
1709	Denmark . .	15	1818	Austria . .	18	1856	Greece	8
	Norway . . .	13	1821	Ireland . .	11	1859	Rumania . . .	7
	Spain . . .	11	1830	Holland . .	10	1861	Italy	6
(1790	United States)	(14)	1832	Saxony . .	23	(1869	Argentina) . . .	(3)
1801	France . . .	21	1834	Serbia . .	17	1871	German Empire	10
	England and Wales . .	13		Württemberg	21		(Canada) . . .	(6)
			1837	Switzerland	9	1880	Bulgaria	8
	Scotland . .	13	1841	Portugal .	10	1897	Russia	1

* Only eight countries date their census as far back as 1800; only sixteen as far back as 1850. Turkey has never had a census at all. The very remarkable census of Sweden was taken every year for the first three years, then every three years till 1860, since which time it has been decennial. It is further remarkable—like the almost equally complete census of Finland, which was undoubtedly an outcome of Swedish culture—for having been taken invariably on December 31 throughout its long history of 170 years. Most censuses, like our own, have fluctuated between a variety of dates within the year.

In cases like these, where the facts of population growth are known, one finds increase the rule; persistent, almost unfailing increase. Even in India, in spite of famines, each census shows a larger population than its predecessor. In the long census series of Sweden there is a single decrease of population of 35,000 between 1805 and 1810. So there was in Finland in that same period, and also a second of 74,000 in 1865–1870. The apparent exception to this rule of constant growth is Ireland. She had eight million inhabitants in 1841 and now has less than four. This, however, merely means that we must look outside of Ireland for most of the Irish. It is not a biological failure of Ireland to grow. There is no lack of Irish. We have a good many of them in the United States. Emigration has removed the Irish from their land, and emigration has shifted enormous masses of people all over Europe, though no other country shows effects so great as this.

Tendency of Rate Growth to Slow Down

Next to the universality of growth I find most striking the tendency in the larger countries for the rate of growth to slow down. In our own case,

between 1800 and 1820 our population increased from 5.31 millions to 9.64, an increment of 4.33 millions in twenty years, or 216,000 a year, 4.08 per cent of the 5.31 millions at the beginning of the period. At 4 per cent a year twenty-five years growth would double the population. But

Table II—Annual Percentage of Growth of Population for Countries Counted for a Century

Country	1800–1820	1820–1840	1840–1860	1860–1880	1880–1900	1900–1910	Pop. in 1910
United States	4.08	3.85	4.21	2.97	2.52	2.10	92,000,000
United Kingdom	1.56	1.38	.45	.98	.91	.91	45,000,000
France*	.58	.59	.38	.22	.14	.19	39,000,000
Germany*		1.15	.73	1.04	1.26	1.53	63,000,000
Spain	1.25	.60	.35	.40	.50	.72	20,000,000
Norway	.50	1.51	1.32	.86	.93	.75	2,000,000
Sweden	.51	1.07	1.15	.91	.62	.75	5,500,000
Denmark	.96	.84	1.26	1.12	1.15	1.26	3,000,000
Finland	2.07	1.13	1.04	.90	1.58	1.48	3,000,000

* Less Alsace-Lorraine.

in the next twenty years the percentage fell to 3.90. From 1840 to 1860 it rose again to 4.22, but since that time it has fallen steadily to 2.98, 2.52, and 2.10. The last period is taken of ten years only, in order to stop before normal tendencies were interrupted by the war. At the century end our period of doubling had extended itself from twenty-five years to nearly fifty. All these American values are unique in magnitude among the data, as the table shows. Half of the increments are of less than one per cent. Moreover, this large but strongly declining American rate of growth falls in a period during which 33 million immigrants have come to our shores. Not all in one generation, of course. All of the early immigrants were dead before the last ones came, but their numbers were more than replaced by their offspring. But the inclusion of the immigrants must be noted. The large growth is not biological growth of the United States, and the falling off in growth was much greater than appeared in the figures because it was precisely in the latter years that immigration was largest. Another factor that has tended to mask the diminution of our rate of growth is the decrease of mortality through the century, which keeps many alive at modern censuses who would not have survived to be counted under earlier conditions.

For the United Kingdom the annual increment has never reached two per cent, and the same general falling off of the rate of increase is evident. Emigration here works against population increase. Some 16 million British subjects have left the kingdom for places out of Europe. Attention has already been called to the diminution of Irish population from this cause. That undoubtedly tended to depress British figures of population growth,

though the Irish decrease of population has been very moderate since 1880. England and Wales alone show the same slowing down of the rate of increase but give values more regular than does the Kingdom as a whole, the six percentages being: 1.75, 1.63, 1.31, 1.47, 1.26, 1.09.

If we could attach any value to early *estimates* of British population—5,450,000 for 1650 and 6,400,000 for 1750, for England and Wales—there has been an enormous acceleration of growth with the coming of the age of industry, the agricultural century 1650–1750 showing little more than a sixth of one per cent annual increment, while the industrial century 1750–1850 averaged 1.8 per cent. There are indications that the industrialization of any country has a tendency to increase its population greatly. But the nineteenth century has seen England's rate of increment decline again.

For France the facts are notorious. The rate of increase of the population is approaching zero. The population is already stagnant and threatens an immediate decline. The annual percentages record this fact; 0.58, 0.60, 0.46, 0.22, 0.14, and 0.19 for 1900–1910. These figures exclude Alsace-Lorraine, to use figures that are comparable before and after 1870.[1]

For the German Empire there are, of course, no figures before 1871; but values compiled for the equivalent area for 1816, 1837, 1858, and 1867 enable us to interpolate values for 1820, 1840, and 1860 that have interest, though the German figures have not the security of the others. One thinks he sees the prosperity and industrialization of the new Empire expressed in accelerated growth of population above the rate of agricultural days. The growth is accelerating to the end of the series. Signs that a turn has come now are that the rates from five-year periods show an annual figure for 1895–1900 of 1.56 per cent, 1900–1905 of 1.51, and 1906–1910 of only 1.41.

The Spanish figures are irregular, as are those of Finland. Norway and Sweden show a decline in rate of increase. Denmark shows a tendency to increasing rate in the only country in the world where agriculture has undergone a revolution in the hands of the farmers, and unquestionably more food is being produced from the same soil today than ever before, with the country resisting industrialization. In the previous century Denmark had an annual increment of 0.37 in 1769–1784, and 0.71 in 1784–1801. Sweden and Finland have values in the eighteenth century too between 1750, 1760, 1780, and 1800, making the whole Swedish series of increments, in hundredths of one per cent: 83, 50, 54, 50, 107, 115, 95, 63, 75. That of Finland is: 158, 176, 127, 207, 114, 105, 90, 158, 148.

Malthus Put to the Test

Now come echoes of Malthus and his alarm lest the rapid multiplication of population overwhelm civilization.

[1] The annual increments for Alsace-Lorraine are surprising. As they are not included in either France or Germany I give them here, putting asterisks for the value 1860–1880, the period of change of sovereignty: 2.07, 2.02, 4.29, ***, 1880–1890, 0.21, 1890–1900, 0.72, 1900–1910, 0.90. Big values under France, small values under Germany.

In 1798, when population counts existed only for Scandinavia and Spain with a single census of the United States, Malthus put on record his conviction—which his followers have erected into a law—that *Population, when unchecked, increases in a geometrical ratio. Subsistence only increases in an arithmetical ratio.* Looking about for facts to substantiate this doctrine Malthus finds his best support in the United States. "In the United States of America, where the means of subsistence have been more ample, the manners of the people more pure, and consequently the checks to early marriages fewer, than in any of the modern states of Europe, the population has been found to double itself in twenty-five years."[2]

This attracts a certain amount of attention because of the fact that the first enumeration of the United States was made in 1790, and only eight years had elapsed when Malthus wrote. The only base of Malthus' assertion must have been some estimate of population from colonial days.

But, as a matter of fact, what have the fourteen census enumerations shown about our increase of population? In what periods has it doubled its numbers? It doubled the numbers of 1790 in 22.6 years, again in 24.4 years, and twice more in 23 years and 30. That was 34 years ago, in 1890, and we are still 13 millions short of another doubling. To judge from the annual increments the doubling now in process will take 40 years or more. Had our population doubled in every period of twenty-five years, as Malthus asserted it was doing, we should have had 125,730,000 people in 1915. We actually had 98,000,000 at that date, over 27,000,000 short of his estimate. And this in spite of the fact that our biologic growth—the only sort of growth that Malthus considered—had been augmented up to 1915 by 33,000,000 immigrants, people so far beyond Malthus' horizon that the very steamships which brought them here were inconceivable in his day.

It is obvious that Malthus' reasonings were unsound. In spite of the support given to his estimates of purely biologic growth by a huge immigration, which, I repeat, was without example in those days and of which he could have no expectation, his estimates went far beyond the actual growth of our country because he was unaware of a tendency in population growth to slow up, which the future was to develop. It would seem self-evident that estimators of future population should base their estimates on the observed facts. Malthus could not do so, for the counts had not yet been made; but his successors have not utilized their opportunities. The United States Census of 1860 estimated the population of 1900 at 100 millions, possibly because it was such a nice round sum for a century end! However, when 1900 came there were but 77 millions present to be counted. So well-informed a man as James J. Hill estimated in 1906 that our population would be 117 millions in 1920. It was really less than 106, a falling off from the estimate of 11 millions in the brief period of fourteen years. All these estimates err on the long side. None of the men who made them seems to be aware that the rate at which population increases is distinctly

[2] Essay on the Principle of Population, etc., 1798, p. 20.

slowing up. Now that we are beginning to check the free entry of immigrants the slowing up will become yet more pronounced. The current estimates for 1950 or 2000 are certainly much too large.

Measured periods of doubling now known, but none of them made in Malthus' day, are for Finland, 49 years to 1800, 58 years to 1858, and something like 62 years the third time; for the United Kingdom, 70 years; for England, 45 years the first and 55 years the second time; for Sweden, 105; for Spain, 131; for Denmark, 91. France gives no sign of ever doubling. In the Argentine Republic the population has doubled from the 1,737,000 of 1869 in 21 years, a second time in another 21 years; but the third doubling is proceeding so slowly that it looks as if 50 years would be needed to complete it at 13,896,000 people. The estimate of population for 1921 is 8,700,000. In the Argentine, as in the United States, a large immigration has swelled the biologic increase—for the size of the country quite as large an immigration as ours.

Although Malthus stated that the conditions in the United States were more favorable than anywhere else, he used his "American" rate of increase—doubling in 25 years—as a normal one. To illustrate his arithmetical and geometrical ratios for instance, he estimated that the 7 million English of 1798 might become 14 millions in 1823 and their food become food for 14 millions; but in 1848 they would be 28 millions with food for 21 millions; in 1873 they would be 56 millions with food for 28; and in 1898 they would be 112 millions with food for but 35 millions, leaving 77 millions of people without food! Malthus arrives at an absurdity by arguing from premises that are untrue. England did not have 112 millions in 1898. With Wales it had less than 32 millions of people. If it had food for 35 millions it had more than enough.

Increase of Man and His Food Compared

Malthus' doctrine of the arithmetical ratio with which food increases has no foundation even in theory. If man, "unchecked," may double and quadruple his numbers, so may the plants that he uses for food, if similarly unchecked. "Linnaeus has calculated that if an annual plant produced only two seeds—and there is no plant so unproductive as this—and their seedlings next year produced two, and so on, then in twenty years there would be a million plants."[3] Food nowadays does not "increase" at all. Man produces it, stimulated by the hope of profit exactly as when he produces shoes or nails. If prices go up, he is likely to produce more; if down, he inevitably produces less. In producing crops man makes it his business to see that all possible checks are removed from their multiplication.

Darwin's own statement is a model of scientific opinion. "We may confidently assert that all plants and animals are tending to increase at a geo-

[3] Charles Darwin: The Origin of Species, London, 1886, p. 51.

metrical ratio."[4] No word of the hunger that Malthus in 1798 insisted was the imminent check to population. Indeed, Darwin wrote in 1859, "The causes which check the natural tendency of each species to increase are most obscure."[5] In fact, it appears to be the substance of his teaching that species of animals and plants are under the necessity of having an extraordinary power of reproduction just to maintain themselves in existence, so many are the dangers and enemies that threaten them with extinction, especially in the youth of the individuals.

The distinction between rates of increase of man and his food is not sound. Both are organic, and both show the same tendencies. What difference there is is wholly in man's favor since he is capable of foresight and plan while the organisms that he feeds on are not. He protects his crops and his flocks from the dangers and the enemies that threaten them. He had made beginnings of this long before Malthus' day by his science of agriculture and animal husbandry. Since then he has gone much further in his control of insect and fungus pests, but his chief means of increasing his food has been through the extraordinary development of transportation.

Malthus, living just at the beginning of the nineteenth century, was satisfied that "the power of population is indefinitely greater than the power of the earth to produce subsistence for man." Yet for a century and a quarter after Malthus food has certainly increased faster than mankind.

In 1798 men stood in a relation to their food that had changed little in centuries. Food was produced, in all but the rarest cases, near the place where it was consumed, and a very large proportion of mankind was engaged in producing it. Today it ordinarily comes hundreds or thousands of miles to our tables and is produced by a special, distinctive class of workers—the farmers, a smaller and smaller proportion of all the workers in the more civilized countries. In those days the world was overwhelmingly agricultural, even in Europe and the United States. The physician, the minister, the judge, the merchant, and even the pedagogue had farm or garden and raised no small portion of his family's food. In 1798 the mass of mankind gave the main effort of their lives to winning food for themselves and family directly from the ground. Most men in those regions now, or the more progressive, industrial part of them, work at making other things—what Mr. Strauss calls "things in the saddle."[6]

Malthus did not know. He felt sure enough of many things. He thought and wrote much about the future but had no inkling of the new epoch that was about to dawn for men, the age of steam and steel, of engines and machines and motors, of capital organized, of tele-communication and transportation. And it was precisely these things, just on the modern side of his horizon, that have put food back into a minor place and have put things-not-food so much to the fore.

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[4] *Ibid.*, p. 52.

[5] *Ibid.*, p. 53.

[6] Samuel Strauss: Things Are in the Saddle, *Atlantic Monthly*, Vol. 134, 1924, pp. 577–588.

The Campaign to "Eat More Food"

One of the newest things in this old world is our iterative education by advertisers to "Eat More Food." Raisins began it, I think, when the California growers found they could produce far more than the American people was in the habit of eating. As an incident they popularized raisin bread. Then it was "Eat More Oranges," and we were told about the vitamines we needed and could get only in that way. The Brazilians, loaded with accumulated coffee crops, threaten a campaign to teach us that we can safely and with advantage drink more coffee. To dispose of the too abundant wheat of our own Northwest in 1924 we were urged to "Eat More Bread," and for those who had diversified and were abounding in dairy products we should "Eat More Butter." The Norwegians gather from the icy seas vastly greater crops of fish than they can hope to consume at home, even though they make three meals a day of it; and they take it to the Catholic lands of the Mediterranean, praying, good Lutherans as they are, for the continuance of Catholic fasting in those regions. But when Norway inclines toward total abstinence and would limit her use of Spanish wines, she is promptly told to drink more wine or the Spaniards will eat no more of their fish. Even the United States Department of Agriculture, in its zeal to do something for the farmer, has bulletins in the post offices suggesting that we eat a great variety of kinds and cuts of meat.

It is a campaign over wide areas to induce consumers to use more of the producers' crops of food. Food looking for people to eat it is a condition to be reckoned with in these days. We can produce food faster than people can eat it. It has become like the output of a factory. We should be glad to produce more if there were more buyers, *and we could easily do it!*

A bumper crop is now a disaster. Congratulate a farmer on the biggest potato crop of a generation, and he doubts if it will pay to dig.[7] The only relief for the Northwest, where the wheat crop was too abundant, came when it was learned that the crop in some parts of the world was distinctly short after all.

How can it be possible for men to thrive on short crops and be ruined by abundance? Time was when large crops brought universal prosperity and rejoicing. Had not Thanksgiving Day just that origin?

What achievement of our mechanical and industrial age is more distinctive than that it has relegated food, i. e. *food as nourishment*, to a subordinate place among the objects for which men labor?

As near as I can learn there was no road in the world in Malthus' day on which vehicles were moving goods at six miles an hour. On the sea, when things went well, double that speed might be made. Today millions of tons of wares are always moving about at ten to twenty miles an hour, and thousands at speeds much higher.

[7] This is now the case in northern Michigan.

The Crops of Today Money Crops

The crops of today are not merely transported crops, they have also become money crops. Today a farmer almost refuses to count at all the food consumed on his table if he raised it himself. Russians, colonizing the Brazilian backwoods a century after Malthus, produced food crops in great abundance but, in the roadless impossibility of getting them to market, abandoned their settlements for the open plains of the Argentine. But did not the pioneers in the American forests put up with just that sort of privation? So far from finding their condition desperate, the settling of the region often sent them off anew in search of another frontier. By all accounts their money crops were few.

The markets of the modern money crop are remote. The farmer has little knowledge of them. His only index of success in his labors is the price he gets. Of this price and the elements that combine to fix it he has so little understanding that he is ready to listen if you suggest that avaricious men depress it to deprive him of a return for his labors. Fortunately the fluidity of the stock of wares in the modern world is so great that such artificial price making is very difficult. A low price indicates poor farming nowadays, so greatly is the farm concept changed. A high price indicates good farming. So the Danes judged it. When steam transportation began to bring to Europe the grain from American prairies the price of Danish grain told them their farming was bad. They set themselves to produce butter as a better product for Denmark, not, I suppose, without plenty of hardship among Danish farmers in the transition; but a good price and steady for Danish butter tells them that they are farming well.

The universal production of money crops has created need for salesmen farmers. Where once the good farm was good soil with the right supply of water and a growing season long enough to grow a crop, now its most important attribute is nearness to a populous and wealthy market. Where the good farmer once was a man skillful in growing and harvesting crops, now he must above all know how to sell them. Success at selling a poor crop may bring prosperity, failure to sell a good one bankruptcy. And, similarly, poor soil badly watered near a large city makes a better farm than the best land in a solitude.

The best salesmen among farmers have sold their own crops and their neighbors' as well. Oftentimes the profits of salesmanship have taken them out of active agriculture into active business. They are the middlemen who capitalize their skill in selling. They do this to their own advantage. If combinations of farmers choose they may hire their services at the value of good salesmanship in the market. It is high.

The agriculturist who raises what he likes to raise and waits for buyers to come must not complain if he sees hard times. A money crop demands that some one go out and sell it.

Food crops become money crops have attracted money getters the world over, not to raise them but to move them, to buy and sell them for

profit. Transportation of food that results from knowledge of the world's markets has led to the making of fortunes. Naturally the fortunes went to those who put knowledge and initiative into the affair. They could not go to the raiser of the crop, whose part has been too often routinary. Still his routine labors have become possible on vast virgin territories by means of the middlemen's knowledge and initiative. He cannot complain that they have taken the fruits of his labors away from him. They have given him the possibility of doing business as he prefers to do it.

The Fear of a Food Shortage

Farm machinery has made other fortunes and employment for many men at good wages. Food advertising and food selling have doubtless come to stay, for they profit those who carry them on. The result has been abundance of food. Men's effort for profit has given every one better food and more abundant than ever before. Not hunger has driven them at all. The same desire of profit will yet make practicable for us the fixation of atmospheric nitrogen for fertilizers. It may yet give us synthetic foods. It will certainly affect our food supplies in ways we do not dream of. We have no reason to suppose that hunger will be the motive that drives us to these things. Hunger has become rare in the world. It is difficult for it to survive the glare of publicity, in the abundant stores of food and the speed of transportation, so eager are the well-to-do to feed those who are in want. When the cables announce that millions are starving in Russia, other millions send them food and still have abundance to eat at home. Furthermore, as is well known, the check of population growth, or the diminution of the size of the family is most pronounced in the more prosperous classes, those precisely from whom any fear of hunger is most remote. Instead of doubling their population with every quarter century the countries that thrive show a growth so hesitating that the doubt arises whether they will be able to maintain themselves in the face of their enemies, whether they are not in danger of national suicide. Yet there are thoughtful men today who tell us they share Malthus' alarm lest men become too numerous to find food on the earth. They admit the present amazing increase in the supply of human food but think we must regard it as something of an accident that cannot be repeated. "The industrialization of the Caucasian world which has gone on at such a rapid pace during the last fifty years has provided for more people, it is true. In fact population increase, though rapidly rising, has not really caught up with the increase in production made possible by the multitude of mechanical inventions. But why has this come about? There is one reason and only one reason for the situation. We have had a reserve of new land to draw upon."[8] How similar this to the lament of Tertullian in the beginning of the third century: "Most pleasant farms have obliterated all traces of what were once dreary and dangerous

[8] E. M. East in *World Agriculture*, Vol. 2, 1922, Amherst, Mass.; ref. on p. 130.

wastes; cultivated fields have subdued forests; . . . sandy deserts are sown; . . . marshes are drained; and where once were hardly solitary cottages are now large cities. . . . Everywhere are houses, and inhabitants, and settled government, and civilized life. What most frequently meets our view is our teeming population; our numbers are burdensome to the world, which can hardly supply us from its natural elements."[9]

Tertullian did not know what time was to bring forth. Dr. East does not know what the future has in store for us, but he might learn that population increase is not rapidly rising but instead distinctly slowing its rate. And it should not be hard to believe that men will further increase their powers over their environment. Up to the present that process has been strongly accelerating in the sense that more progress is often now made in ten years than formerly in hundreds. This very acceleration in man's conquest of nature is disquieting to Dr. Raymond Pearl.[10] Are we not overdoing everything? Surely we cannot go on like this—while the world's population increases (in a century) only two-and-a-half times, augmenting our iron output 50- to 70-fold, our cotton 20-fold, our shipping 8-fold, our railway mileage by 17,000-fold, and our telegraphs 300-fold! It is true we use up resources that we miss later. Our forests are largely gone. Our coal and our copper seem likely to come to an end, though substitutes are in sight. However, the comparisons Pearl makes would be less alarming if put somewhat differently. New powers have a tremendous expansion in their infancy and later slow up as world needs approach saturation. Automobile output will some day slow up a bit when the main world demand has been satisfied. In the first period, however, the rate of production rises with tremendous rapidity, to slow down later. So these new developments that he cites increase in their first years vastly more than mankind whose beginnings lie far back in the mists of time. If we could divide the life of mankind into ten equal periods of time, and similarly the period of active exploitation of iron and cotton and shipping and railway building and telegraphs, it would be instructive to compare the rate of expansion of each in the latest tenth of the period involved for each. If the cotton period dates from 1800, the railway period from 1830, and mankind from a hundred thousand years ago, the last tenths would date back ten thousand years for man, twelve years for cotton, and nine for railways; and the comparison would lie between the increase of men in ten thousand years, of cotton production in the last twelve years, and of railway building in the last nine. The results would be less discordant.

The Luxury Check

But, if there is no ground for expecting an indefinite increase in the numbers of men on the earth, and if it is true that we are now and may always be able to supply everybody with abundant food, what is the agency that

[9] Quoted in A. M. Carr-Saunders: The Population Problem, Oxford, 1922, pp. 19–20.

[10] Raymond Pearl: The Population Problem, *Geogr. Rev.*, Vol. 12, pp. 636–645.

is now beginning to check human expansion and that may be relied on to keep the future number of mankind within limits? It appears to be the growing desire for luxurious living. Even the general mass of mankind among us are beginning to spend more for other things than for food. Free loaves were an enormous bounty in ancient Rome. They would be a trifling one today. A committee of the Senate reported in 1895 that in a "normal" workingman's family—husband and wife and not more than four children under fourteen—an average from thousands of budgets showed that 41 per cent of all family expenditure was for food. A recent investigation by the Department of Labor gets an average for 12,096 families of 38 per cent for food. The proportion appears to be diminishing. "Things are in the saddle" in these days, and it is increasingly difficult for men in average or better than average circumstances to keep up with their neighbors in dress, in housing, in automobile expenditure, and in social expenses. Not at all in food. If our grocer's or butcher's bill alarms, it is food-for-entertainment, food-as-display, and food-as-luxury, not food-for-nourishment that we have bought. Those families in which food-as-nourishment is a matter of course, a very minor expenditure, are almost certain to be families without children or with few children. If there are people in the world who lack sufficient food, their families are likely to be not small. They are contributing to the increase of the race in spite of any pressure hunger may exert upon them. The falling off comes almost exclusively from those to whom hunger is unknown. It is a complete reversal of Malthus' doctrine. Population is effectively checked already among the more prosperous nations and especially among the more prosperous members of those nations. "Become civilized, become cultured, enter the social swim, and commit suicide to your race; have no children, for they are a great trouble and a hindrance to your career"—this was the theory and practice that Roosevelt regretted to see abroad in our land and in the world.

This is far from any thought that Malthus entertained. It is a luxury check now operating among the so-called progressive nations. It seems likely to become more and more widely effective throughout the world as the missionary forces of Consumptionism teach all the world to want more things, teach every one the Consumptionist doctrine that to be supplied with food, shelter, and clothing alone among material things is to lead a dull life, dull to the point of intolerability. The doctrine tends to spread and may yet claim all continents for its abiding place and all men for its votaries.

We see these tendencies, and that is as much as is permitted us. We do not know what the future will bring forth.

Predictions of the population of the future are equally impossible. The current ones do not even give heed to present tendencies. We do not know what future population will be. Such numerical data as we have of the facts of the last century suggest a progressive slowing up of population the world over. The very definite intention in the United States to have fewer

additions by immigration shows the same sort of feeling as the diminishing size of families. We want to keep up our "scale of living." We want more, not less, of luxury and pleasure; and this desire is more real as a check on population in the more civilized countries than hunger is. There is no indication of increase at geometrical ratios in census figures. It is entirely possible that the mass of men may always be sufficiently or even abundantly fed on our planet.

If the population of the earth has doubled in the last century, which we do not know, for great numbers of men have never been enumerated as yet, it is entirely reasonable to expect that they will not double in the next.

ANCIENT TRADE ROUTES FROM CARTHAGE INTO THE SAHARA

By Count Byron Khun de Prorok
General Director of the Excavations of Carthage

The new excavations now in progress at Carthage[1] have revealed many objects and elements strange to the Phoenician culture of the ancient city. In the Temple of Tanit have been found works of artistic design purely Egyptian; some of the objects discovered are of origin unknown; others probably derive from the interior of Africa.

It has been frequently pointed out that, great as is the obstacle imposed by the Sahara, it has never been a complete barrier to intercourse and in prehistoric times probably was less so than today. Gsell describes North Africa (Barbary) as a veritable island, "the Isle of the West," as the Arabs say, surrounded by the Mediterranean Sea, the Atlantic Ocean, and a "sea of sand."[2] The establishment of the Phoenician colonies, especially Carthage (800 B. C.), on the Mediterranean coasts of Africa must have greatly stimulated a trans-Saharan trade which archeology indicates was already in progress; and we can imagine that a special impetus must have been given by the famous voyage of Hanno to the western coast of Africa in 550 B. C., as is related in the Periplus of Scylax the Greek. For the trans-Saharan traffic in gold and precious stones, ivory and elephants, and slaves, Carthage was the central outlet. It remains for us to trace the routes of this old trade.

Modern means of scientific exploration are now opening up to the geographer and archeologist areas that hitherto have been difficult and dangerous of access. Especially is this true of the automobile and airplane. The great explorers of Africa, such men as Barth, Rohlfs, and Duveyrier, were intrepid pioneers; but their researches were restricted because of the slow rate of travel by camel and because of the antagonism of desert tribes, now for the most part subjugated. Many an expedition sent out to explore the Sahara has met death at the hands of the Tuaregs. A terrible disaster was that which overcame Colonel Flatters' expedition when 90 men perished (1881). In the course of our work the coming season we hope to bring back specimens of the extremely poisonous desert plant (*Hyoscyamus falezlez*) which, mixed with dates and given by treacherous natives to the ill-fated expedition, contributed to the final disaster. It was only in 1916 that Father Foucauld was massacred by Tuaregs at Tamanrasset on the southern edge of the Ahaggar. The conquest of the desert by modern means of locomotion was been described by E. F. Gautier in the preceding number of the

[1] See the author's paper: Recent Researches on the Peninsula of Carthage, *Geogr. Journ.*, Vol. 63, 1924, pp. 177–189.

[2] Stéphane Gsell: L'Algérie dans l'antiquité, new edit., Algiers, 1903, p. 18.

Fig. 1

Fig. 2

Fig. 1—Panorama over the site of Roman Carthage.

Fig. 2—The end of the Roman road that in antiquity reached the island of Jerba by a causeway now submerged. In summer the water is low enough for camels to cross, whence it is known to the Arabs as the "camel bridge."

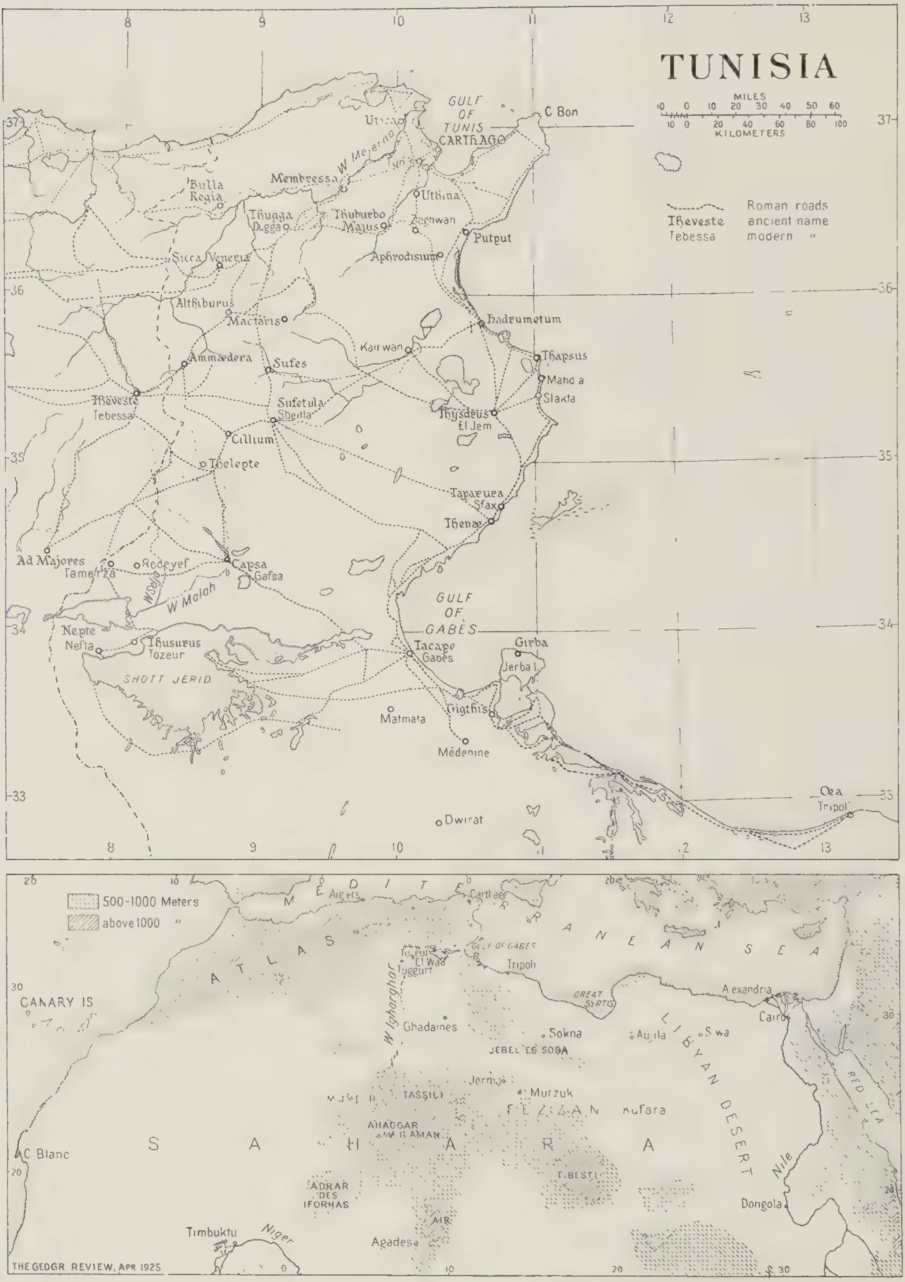

FIG. 3—Carthage in relation to the Sahara. Above: map of Tunisia showing Roman roads (according to Tissot, with additions from Müller). Scale 1: 5,000,000. Below: map of northern Africa to show situation of Carthage in relation to the Sahara as a whole. Scale approximately 1: 50,000,000.

Fig. 4

Fig. 5

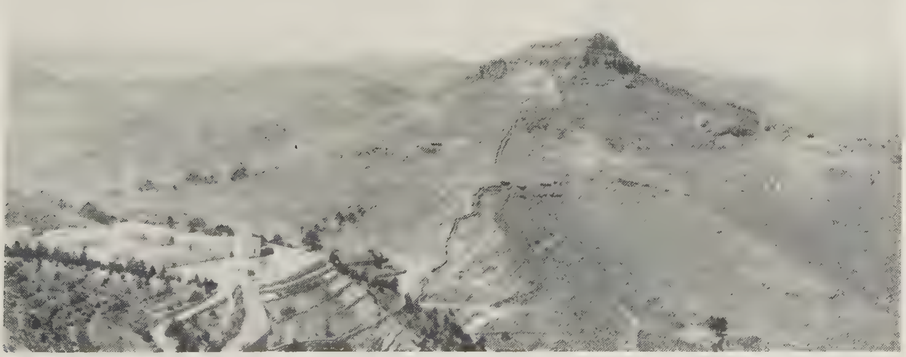

Fig. 6

Fig. 4—The amphitheater of Thysdrus (El Jem), one of the finest monuments of Roman rule in North Africa.

Fig. 5—Traces of the Roman road at Tacape (Gabès).

Fig. 6—In the country of the Matmatas (south of the road from Gabès to Médenine). Here are prehistoric caves, the "eagle's nest," and cave dwellings of the modern Berber inhabitants and—a symbol of the peace that has rendered these refuges unnecessary—the French garrison.

Geographical Review.[3] But the conquest still seems only partial. M. Gautier reminded us of the tragic death of General Laperrine in an airplane accident in the Adrar des Iforhas in 1920. The latest news concerning the widely advertised plan of an automobile tourist route to Timbuktu is that M. Citroën has been compelled to abandon it because of the attitude of the Saharan tribesmen.

But, whatever the fate of commercial trans-Saharan schemes, the automobile will become an indispensable adjunct to scientific expeditions. The saving that can be effected by its use is immense. What it took Duveyrier and Colonel Flatters ten weeks to traverse can now be done in as many days. Our task, however, is to explore methodically the ground that is crossed. Twenty years ago a detailed scientific study of the great central plateau of the Sahara, the Ahaggar, would have been impossible. It is our hope to explore methodically and progressively this little-known region.

FIG. 7

FIG. 8

FIGS. 7 and 8—The strange many-storied dwellings of Médenine, known as *ghorfa* (see reference in footnote 8).

To comprehend the importance of Carthage as a center of routes to the interior one must realize its situation in relation to the Ahaggar massif and the depression of Fezzan lying between this and the Tibesti massif. The route of Fezzan offers the best natural road to the Sudan as regards topog-

[3] E. F. Gautier: The Trans-Saharan Railway, *Geogr. Rev.*, Vol. 15, 1925, pp. 51–69.

raphy and water supply. One cannot do better than quote the following summary:

For trans-Saharan communications the Fezzan offers the most important historical route after the Nile. An intimation of this is to be found in the persistence of the ancient geographical names—Mons Ater, Phazania, Jerma [Garama], which preserves the illustrious name of the Garamantes; and on the events which explain this persistence we have historical light. The Syrtes were almost completely under Carthaginian dominion, and it is clear that the Carthaginians were interested in trans-Saharan commerce. Herodotus, five

FIG. 9

FIG. 10

FIG. 9—The Punic mausoleum at Dugga, restored by the Service des Antiquités.
FIG. 10—The capitol of Thugga (Dugga).

centuries before Christ, knew the road of Fezzan. The Roman Empire, successor of Carthage, exercised more or less control over Phazania; time and again it sent thither military expeditions. History has preserved the record of two Roman expeditions that pushed their way through Fezzan to the country of the hippopotami. The Empire left archeological monuments there as far south as Garama (today Jerma), the ancient capital of Fezzan.

Pliny gives us detailed information concerning the two roads which still connect Tripolitania and Fezzan. The longer and easier, because it is well furnished with sources of water, passes by Sokna and Mons Ater. The Romans under Vespasian in 70 A. D. discovered another route to the west which reduced the journey by ten days but which was much harder. This is the route from Tripoli to Murzuk followed by Barth, who crossed the solitudes of the Hammada el Homra. All this is perfectly definite knowledge. This country, whose existence for two millenniums has been bound up with its situation on a highway,

naturally offered its facilities to European explorers. It was by Fezzan that Barth succeeded in carrying out the first scientific journey across the Sahara to the central Sudan. After him Rohlfs, Duveyrier, and Nachtigal were cordially received in the Fezzan and sojourned there. It is the most open part of the Sahara.[4]

Carthage to Ghadames by Gigthis

On the western border of the Fezzan between Jerma and Carthage lies Ghadames, the ancient Cydamus subdued by the Roman Balbus in his march on the Garamantes. There is no doubt that Ghadames has been a great trading center from earliest times. Duveyrier found there Egyptian sculptures and believes that the place has been inhabited since its prehistoric foundation.[5] He speaks with great admiration of the enterprise of its inhabitants, the organization and extent of the trans-Saharan trade in evidence at the time of his visit.

Last year our expedition visited the probable routes and trading posts between Carthage and the desert. The first of these routes led via Gigthis to the south of the Gulf of Gabès. This section constituted a part of the great Roman road of the littoral running west and east of Carthage to the farthest extremities of Roman Africa. Regarding it and the other Roman roads in Africa two priceless documents have come down to us from the later days of the Empire, the Antonine Itinerary and that known as the Tabula Peutingeriana. The former gives the distances and positions of stations along the roads and resting places (*mansiones*) but omits intervening towns or villages. The Peutinger table gives all the military roads, the stations and cities, temples and baths and storehouses on the way. In some instances the two documents supplement each other, the Antonine Itinerary, for instance, giving data for the Tunisian interior (Byzacium) and the Syrtian Sea area where the Peutinger table is deficient. Tissot[6] has discussed the identification of the roads in the Tunisian region on these and other bases, and more recently they have been interpreted by Konrad Miller.[7]

From Carthage our road, avoiding the protuberance of Cape Bon, proceeds south to the Roman Putput, whence it runs along the shore by the ancient Aphrodisium, Hadrumetum (Susa), Leptis Minor, and Thapsus. Thence the main highway runs through Thysdrus (El Jem), one of the chief foci on the route, no less than six roads meeting here. Before Gigthis is reached we pass the important station of Tacape (Gabès) and the port for the lesser Syrtis (Gulf of Gabès).

The Roman road is visible every few miles along the way, and many old bridges and milestones are to be seen. The milestones are particularly illuminating. They stand solidly upright in heavy stone bases. At the head is often the name of the emperor under whose rule the stone was erected;

[4] E. F. Gautier: Le Sahara, Paris, 1923, pp. 134–135.

[5] Henri Duveyrier: Les Touareg du Nord, Vol. 1, Paris, 1864, pp. 249–266.

[6] Charles Tissot: Géographie comparée de la province romaine d'Afrique, 2 vols., Paris, 1884, 1888; reference in Vol. 2, pp. 51–710.

[7] Konrad Miller: Itineraria Romana, Stuttgart, 1916.

FIG. 11

FIG. 12

FIGS. 11 and 12—Ruins of Thugga (Dugga) in the midst of century-old olive trees. Thugga lay slightly off the military road from Carthage to Theveste.

Fig. 13

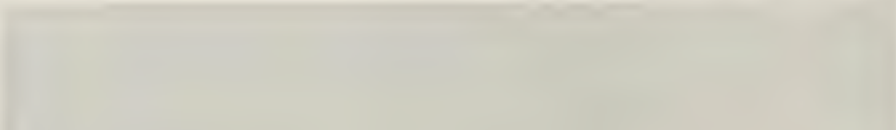

Fig. 14

Fig. 13—The great ruins of Thuburbo Majus now being excavated by the Service des Antiquités.
Fig. 14—The fine Roman bridge at Sufetula (Sbeitla).

Fig. 15

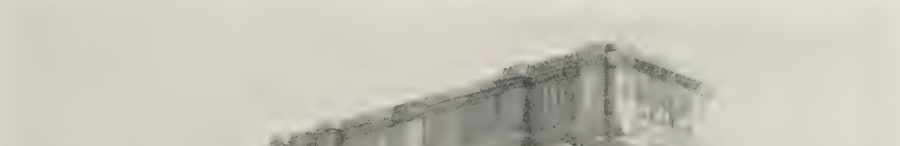

Fig. 16

Fig. 15—The three temples of Sufetula (Sbeitla). Little is known of them: they were probably dedicated to Jupiter, Juno, and Minerva.

Fig. 16—Triumphal arch of Sufetula (Sbeitla) erected under Diocletian.

then come the distances to and from a great center, often Carthage. The date of completion of the road is given, and the carrying out of improvements under such and such an emperor. The inscriptions also give a list of the difficulties to be encountered ahead—marshes, mountains, torrents,

FIG. 17—Reconstructed Roman bridge in the Selja, a route leading to the Sahara.

waterless stretches, etc., and they indicate the class of road, whether a main highway or a local artery.

The route to Gigthis, however, was Phoenician before it was Roman, and on the way we pass the Punic emporia on the sites of the present Mahdia, Slakta, and Tina (Thenae). Ancient Gigthis itself was the halfway city to Oea (Tripoli), Leptis Magna, and Cydamus (Ghadames). The country immediately south of Gigthis offers much of interest in human geography both ancient and modern. Here, for instance, are the curious and often described cave dwellings.[8] At Médenine there are cell-like houses several stories high, and at Matmata there are houses having several stories underground. Matmata occupies a defensive site in the hills.[9] A French fortress

[8] See note on "The Rural Habitations of Tunisia" in this number of the *Review*.

[9] Cf. J. Russell Smith: The Desert's Edge, *Bull. Amer. Geogr. Soc.*, Vol. 47, 1915, pp. 813–831.

has been established there near the Roman outpost of antiquity facing Tripolitania and the Sahara. North of Gigthis lies the island of Jerba (the ancient Meninx), in ancient days reached by a causeway four kilometers long (see Fig. 3). Today, as then, its cultivation is in most flourishing

FIG. 18—A gateway to the Sahara: the gorges of Selja.

condition, thanks to the industry of its inhabitants. The island and the adjacent mainland were the land of the lotus eaters. From Gigthis traces of ancient ruins and routes are seen leading south across the mountains from the Jebel Dwirat in the direction of Ghadames and the farthermost Sahara.

In identification of the old trade routes attention should be called to the importance of the water sources, though of course some have been dug more recently and some have been filled in. To colonize northern Africa in antiquity, as today, two things were essential—water and means of communication. In the summer months there is very little rainfall. The vast constructions built by the Romans and still standing seem to indicate that the climate has not changed materially in twenty centuries. At Carthage the "Cisterns of the Devil," as they are called by the Arabs, are still used: they hold millions of gallons of water. On our way south we passed many aque-

ducts of beautiful workmanship, notably at Aphrodisium and Sbeitla (on our second route). Between Carthage and Mt. Zaghwan there is an aqueduct 90 kilometers in length that used to carry six million gallons of water a day to the metropolis, supplying a population of 500,000 souls.

Carthage to the Sahara by Sbeitla and Nefta

It was by this great aqueduct, passing the Roman Uthina and Thuburbo Majus on the way, that we took our second route out of Carthage to the desert. Both the cities mentioned are at present being excavated by the Service des Antiquités, and a rich harvest is being reaped. From Thuburbo Majus the old road leads to Sbiba, the ancient Sufes, then to Sbeitla, the ancient Sufetula. The road now passes through a veritable park of ruins, an open-air museum, with a succession of splendid edifices silhouetted against the blue background of the African sky. Parts of the Roman road are in an excellent state of preservation here. The next great ruins are those of Cillium (Kasserine) and Thelepte. Here a portion of the road recalls the Appian Way near Rome, for it is lined with tombs.

Various methods adopted by the Romans for the protection of the roads are illustrated in this section. In one place, for instance, where the earth is clayey and easily washed away retaining walls have been built that throw the water into sluices passing under the road. In some places dams have been built to keep the rivers in check. South of Thelepte the road runs through the wonderful gorges of Selja, called by the Arabs the gateway of the Sahara. In their colors the gorges recall the Grand Canyon of the Colorado, and their fantastically carved walls have caused them to be cursed in the legends of the Arabs. The Roman road disappears on the side of the gorge, but we can trace remains of a Roman aqueduct that carried the waters of the Selja River into now waterless desert country. There are prehistoric sites in the gorges of Selja and the mountains around Gafsa, Tamerza, and Redeyef. The Carthaginian Exploration Society is undertaking a separate expedition to excavate and explore them.

The route now approaches the edge of the Sahara and leads to Nefta (the ancient Nepta) and to Tozeur (the ancient Thusurus), the region where in early times dwelt the famous tribes of the Gaetuli.

Nefta and Tozeur are on the border of the region of the great shotts, the legendary Lakes of the Tritons. It is thought that the lakes once connected with the Gulf of Gabès: the mouth of the river of the Tritons (now known as the Wad Malah) is placed near Gabès. Nefta has been named by the Arabs "Mesra-es-Sahara" (Port of the Sahara). This may once have been true literally, as it is now figuratively. Tissot[10] speaks of the remains of a Roman galley found by the Arabs in the Shott el-Jerid. He also gives an effective description of the crossing of the lakes, very difficult except in summer when they dry up. In 1306, Tijeni, the Arab historian, recounts

[10] Tissot, *op. cit.*, Vol. 1, p. 135.

Fig. 19

Fig. 20

Fig. 19—Ruins at Ad Majores, a military station established under Trajan on the threshold of the Sahara.
Fig. 20—Camp of the expedition on the sand that covers the site of the ancient Nepte (Nefta).

the tale of a caravan of a thousand camels being swallowed up in a few minutes in the crossing of the vast marsh. The solitude and desolation of the region is appalling, and the scores of camel skeletons we passed on the way down heighten the awful aspect. The region is about 60 feet lower than the level of the Mediterranean Sea, from which it is separated by a space of about 20 miles only. De Lesseps conceived the idea of flooding the shotts, but his chimerical project was abandoned for it would have meant the destruction of the flourishing oases of Nefta and Tozeur with their thousands of date palms.

We spent several days in investigation of the shotts, and it is hoped that during the prosecution of the long series of researches now in hand the question of the date of the desiccation of this part of Africa may be determined. At present the vexed question permits of no definite conclusion, but I believe that it can be solved by archeological study.

We camped at Nefta on a dune that completely covers the city of antiquity. The dunes here are ever changing, making study of the old civilizations difficult. At present a great mass of sand is approaching and it looks as though the modern town might suffer the same fate as its Roman predecessor. Here we concluded our second route, one of immense interest because of the wealth of ruins along its course. From Carthage to Nefta are the rich remains of no less than 36 towns, the majority entirely unexcavated.

Route via Tebessa

Our third route took us by way of the ancient Cirta (Constantine), an important commercial center under the Romans and a focus of roads. One of these leads to Tebessa, the ancient Theveste. All along the way mausoleums, Byzantine temples and fortresses, and Christian basilicas abound. This is the ancient Numidia, famous of old for its horsemen and today still famous for its olive plantations. A main military artery also led direct to Theveste, 275 kilometers from the "Gate of Theveste" at Carthage via Membressa, Sicca Veneria, Altiburos, and Ammaedara. A short distance southwest of Tebessa is the majestic gorge of Orfana, where every few miles were seen traces of the Roman road cut out of the living rock. The ruts scored by the wheels of the ancient chariots are still visible, and the Arabs today call the valley "Tric el Rareta" (Trail of the Wagons). The plateaus about Tebessa and the slopes to the great shotts are the country known to the Arabs as Nemencha. Today it is desolate and barren, though the numerous ruins attest a former prosperity, and here furthermore are rich deposits of phosphates. The old trail now reaches Besseriana, the ancient Ad Majores, near the modern oasis of Négrine. The architecture of the ruins, half buried in sand, is peculiar, suggesting a Carthaginian origin: further investigation is needed. There is also standing a beautiful triumphal arch built to the Emperor Trajan. Ad Majores seems to have been at a

crossroads of trails going south by El Wad to Ghadames and the Ahaggar and a road east to Gigthis.

Program of Further Work

Here then are three portals to the Sahara. Next season we shall take up the work of tracing the continuation of the ancient routes across the desert to the Ahaggar and the oases in the depression on its eastern border. A starting point will be Ghadames (the ancient Cydamus) whence routes lead east to Egypt and south to the mountains. We shall also visit Jerma,[11] the ancient capital of the Garamantes. An important task will be the photographing of the ancient rock sculptures of the desert depicting the caravans of antiquity. At Telizzarhen (Telisaghé) Barth saw remarkable sculptures with oxen and wagons complete. Other interesting photographic documentation will be the Egyptian sculpture seen by Duveyrier[12] in Ghadames.

On our way to the plateau of the Ahaggar we hope to identify the mysterious Mt. Gyri, the "Mountain of Precious Stones" of the ancients, and perhaps to find whence came the jewels found in the tombs at Carthage. The emeralds of the Garamantes were very famous in ancient Rome. Of great importance will be the discovery of elephant remains. Pliny states that many of these animals were brought from the banks of the Guir, the identification of which has been much discussed, as well as north of the "lakes" of Mihero in the Ahaggar. The water holes of the Wad Mihero, a branch of the Igharghar system, still contain crocodiles.[13] We shall pass the river Igharghar, the great wadi leading northward from the Ahaggar.

The Ahaggar itself is the highest platform of the great massif of the Tuareg Sahara. The Atakor, as it is called, which has a greatest diameter of 250 kilometers, has an elevation of over 2000 meters, and on it the denuded volcanic peaks rise to almost 3000 meters. We hope to scale the culminating point, Mt. Ilaman. On this and other high peaks snow is to be seen at times—this in the heart of the Sahara. Northward the Ahaggar is prolonged by other massifs over 1000 meters in height—the Tassili, Muydir, and Ahnet—while still lower plateaus extending northward connect with the Atlas. To the south are the massifs of Adrar des Iforhas and the Aïr, connecting with the Sudan. Eventually we hope to continue our studies to the last-named massif, which has been identified as the Agisymba Regia of the Greek and Roman historians. Here we shall look for traces of the civilizations from the north in the hope of confirming our belief that in antiquity these people traded with the cities of the north African seaboard.

[11] For the situation of Jerma see the admirable route map from Tripoli to Murzuk in Henry Barth: Travels and Discoveries in North and Central Africa (5 vols., New York, 1857), Vol. 1, facing p. 85.

[12] Duveyrier, *op. cit.*, p. 250.

[13] Cf. Gautier, Le Sahara, p. 74.

THE DISTRIBUTION OF POPULATION IN THE AMAZON VALLEY*

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The Amazon Basin is one of the world's great deserts. An area of 2,000,000 square miles supports a population of less than one to the square mile. It is comparable with the Sahara. Paradoxically the Amazon is a region of great natural riches. The comparative exportation figures cited by M. Le Cointe in his book on the Brazilian Amazon are illuminating.[1] Per head of population exportation from the Brazilian Amazon is 459 francs, a figure only surpassed by the richest countries of the world: for the United States it is 134, for Brazil as a whole 99. Per unit of area (square kilometer), however, the coefficient for the Amazon is only 103, for Brazil 220, for the United States 910.

M. Le Cointe carries the paradox further in expressing the view that the greatest hindrance to Amazonian development lies in the very wealth of natural and easily exploitable products. The extractive industries, of which rubber is paramount, have absorbed the population at the expense of agriculture that makes for permanent settlement. On the other hand, it is the quest for the "black gold" that has led to the settlement of much of the basin. But we shall consider later this prime question of the effect of rubber on the distribution of population in the Amazon. First let us examine the facts of distribution so far as they are known.

Population Statistics

The total population of the tropical part of the Amazon Basin, which covers an area of some 2,000,000 square miles, is probably between 1,500,000 and 1,600,000. Of these about 1,300,000 live in Brazil, divided according to the federal census of 1920 approximately as follows:

Pará	800,000 (estimated)
Amazonas	363,166
Matto Grosso	40,000 (estimated)
Acre territory	92,379
Total	1,295,545

The population of the state of Pará in 1920 was given at 983,507 and of Matto Grosso at 246,612. However, nearly 200,000 of the inhabitants of

*The data contained in this article were gathered during the progress of the Crude Rubber Survey carried on by a special commission of the United States Department of Commerce during the period from August, 1923, to May, 1924.

[1] Paul Le Cointe: L'Amazonie Brésilienne, 2 vols., Paris, 1922; reference in Vol. 1, pp. 283–285.

Pará live outside the Amazon Valley proper, and it is doubtful if the sparsely settled rubber-producing regions of Matto Grosso have a larger population than the figure given above.

In the state of Pará the six north-bank "municipios," or municipal districts, of Faro, Obidos, Alemquer, Almeirim, Monte Alegre, and Prainha (the two last also extend south of the river) had a population in 1920 of 76,320, of which over one-third were in the district of Obidos. The great majority of this population dwells in a belt within 50 miles of the Amazon, though the "municipios" in question extend north to the borders of the Guyanas. Of the southern rivers of the state of Pará the zone of the Tapajóz had a population of 54,740, of which 41,546 lived in the important district of Santarém. The vast Xingú zone had only 14,815 inhabitants, of whom 9343 dwelt in the district of Altamira. It is an interesting fact that the heaviest concentration of population on the Xingú is above the first rapids, or *caxoeiras*, a circumstance largely accounted for by the flourishing *caucho* industry in the Iriry basin. Whereas Altamira is a place of much life and movement, Porto de Moz, located near the mouth and formerly a town of importance, is only a shell. On the other hand, conditions are reversed on the Tapajóz, where the upper river is of little importance as compared with the country bordering the lower river between Aveiro and Santarém. According to the census of 1920 the zone of the Tocantíns had a population of 71,679, of which Cametá accounted for 41,365. The four other municipal districts of Jurity, Portel, Bagre, and Oeiras, located on the Amazon but outside the zone of the three great rivers above named, had a total population of 28,675. Thus, that part of the state of Pará which lies between the Mojú-Tocantíns watershed and the boundary of the state of Amazonas had a total population of some 157,620 people. By far the larger part of this population is concentrated within a strip about two miles wide on each side of the main rivers and their tributaries.

The large island of Marajó, which lies athwart the mouth of the Amazon, had a total population of about 120,000, or about seven to the square mile. That part of the state of Pará below Gurupá on the Amazon and including the islands of the delta, eleven municipal districts on the south mainland within the drainage area of the Rio Pará mouth, and the north mainland districts of Mazagão and Macapá, had 560,775 inhabitants, or considerably more than half the population of the entire state.

The upper basins of the three rivers Tocantíns, Xingú, and Tapajóz, lying within the state of Matto Grosso, have a population estimated at not much over 10,000, most of whom are wild Indians. This, however, includes a great block of unknown country between the Tapajóz and the Xingú. Population estimates of such regions are extremely hazardous. Conditions along the known streams whose native peoples have often been reduced—by disease, war, or flight—give no clue to conditions in the interior. Farabee speaks of the Mundurucus driven from the banks

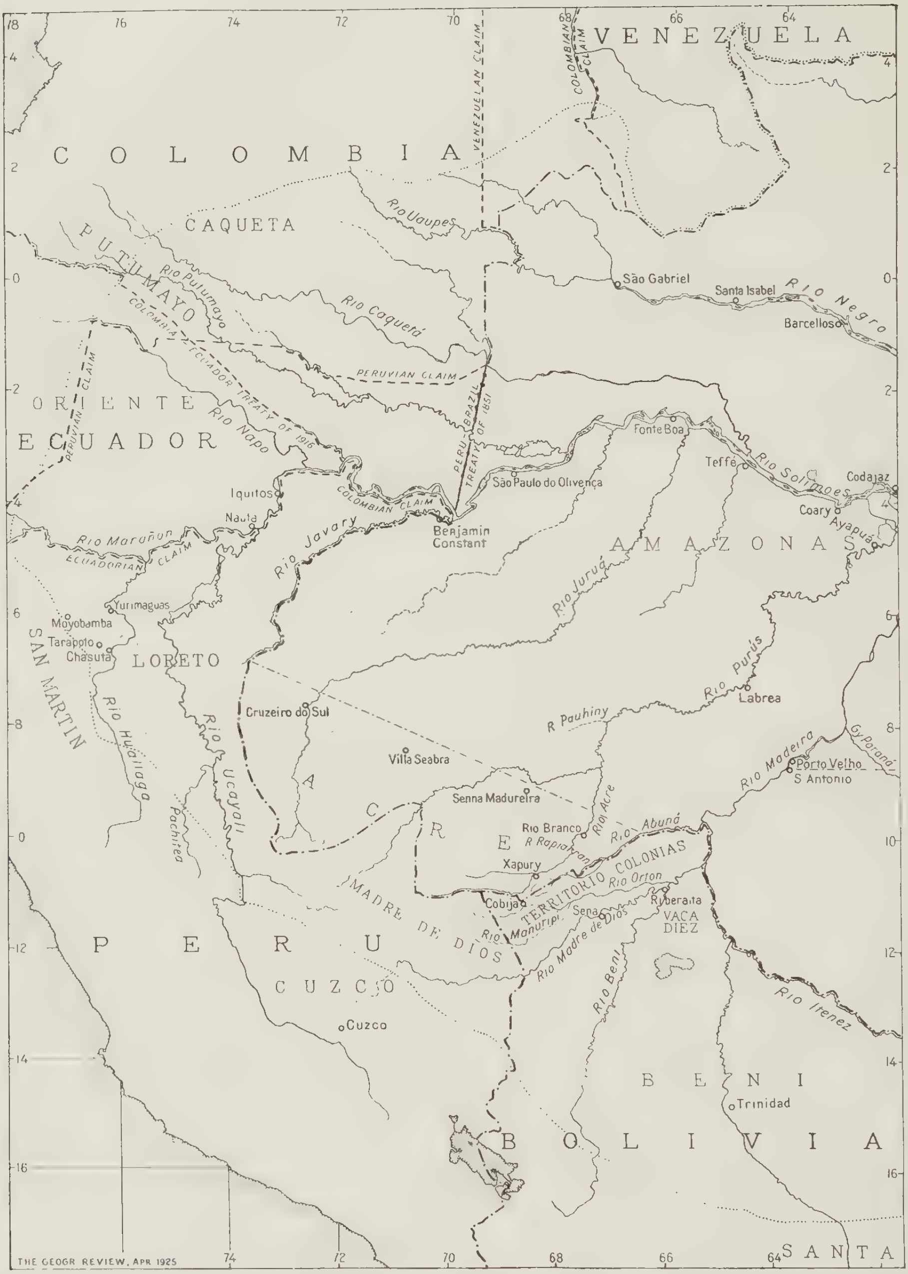
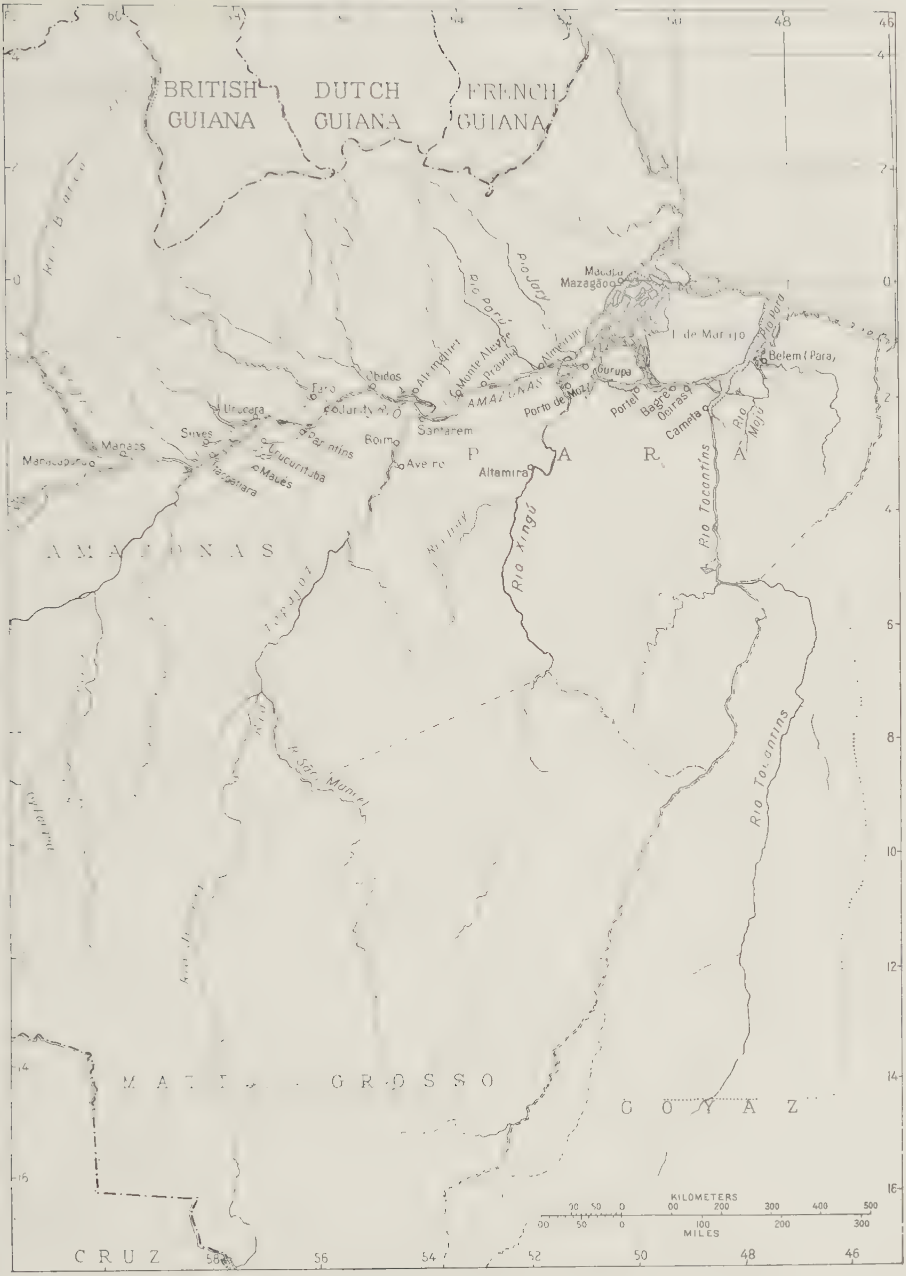


FIG. 1—Map of the Amazon Basin showing localities mentioned in the text. Western half. Scale approximately 1: 15,000,000.



Eastern half. The dotted line represents the approximate limits of the tropical part of the basin.

Fig. 2—Remate de Males (Benjamin Constant), on the right (Brazilian) bank of the Rio Javary.

of the Tapajóz occupying the country from that stream eastward to the divide with the Xingú.[2] Colonel Fawcett reported "large populations of savages" in the forest sanctuary.[3] The enormous district of Santo Antonio do Rio Madeira was estimated by the federal census authorities in 1920 to have a population of only 18,000. At that time an area of probably 250,000 square miles tributary to the Madeira and including, in addition to the district above named, a wide belt of the state of Amazonas on both sides of the main river, had less than 75,000 inhabitants, or about one person to four square miles. All but a small minority of these live in close proximity to the Madeira or to the lower courses of its tributaries.

Of the 363,166 inhabitants of the vast state of Amazonas 75,704 dwelt in the municipal district of Manáos. Above Manáos the zone of the Rio Negro had in 1920 only 20,408, and that of its principal tributary, the Branco, another 7424. However, the population of the latter zone has increased considerably during the past few years. The two districts of Codajaz and Manacapurú on the Solimões had a total population of 24,314. The country which borders the Solimões on its left bank above the vicinity of Codajaz is extremely lightly populated. In fact, most of the region to the north of the upper Amazon is an absolute wilderness, and much of it is still unexplored, inhabited by small tribes of Indians who still live in the Stone Age. The only parts of this area that show any appreciable signs of development at all are Manáos and its immediate vicinity, the upper Rio Branco, which is the center of the balata and live-stock industry of the state, and the country along the north bank of the Solimões from the mouth of the Negro to the neighborhood of Codajaz. The rest of it, so far as it is inhabited at all, is populated by isolated groups of rubber or Brazil-nut gatherers or by turtle or *pirarucú* fishermen. The upper Rio Negro country, which a century ago was a center of considerable activity, is now in a state of complete decadence. The towns, such as Barcellos, Santa Isabel, and São Gabriel, are miserable villages, without any im-

[2] W. C. Farabee: The Amazon Expedition, [*Univ. of Pennsylvania*] *Museum Journ.*, Vol. 8, 1917, pp. 126–144; reference on pp. 128–129.

[3] P. H. Fawcett: Bolivian Exploration, 1913–1914, *Geogr. Journ.*, Vol. 45, 1915, pp. 219–228.

FIG. 3—Remate de Males, upstream section. This forms a panorama with Figure 2.

portance beyond the little trading that still gives them a certain excuse for existence. Though Manacapurú and Codajaz are places of only a few hundred inhabitants, they have potential elements of greater vitality than the moribund settlements on the Rio Negro.

It is probable that the population of the corresponding region to the south of the upper Amazon and lying within the state of Amazonas is between 100,000 and 110,000, or about one person to three square miles. Of these about 40,000 live in the basin of the Purús, and some 25,000 in that of the Juruá. The remainder are distributed between the five districts of Benjamin Constant, São Paulo de Olivença, Fonte Boa, Teffé, and Coary. On account of the great decline of the rubber industry in this territory the process of depopulation has gone even further than in the zone of the Madeira and on the lower Purús and Juruá has assumed the proportions of a veritable exodus. Only a comparatively small minority is still engaged in working rubber, many others having turned for a living to gathering castanha (Brazil) nuts or to fishing. However, the great majority have left the region which, with the exception of certain localities, particularly the Ayapuá castanha zone and the lands bordering the Acre territory, is in a state of frank decadence. Teffé is the only town of the region that presents any signs of vitality.

The triangle which lies between the lower Madeira and the lower Amazon, comprising the three districts of Maués, Urucurituba, and Parintíns, had a population of 32,087 in 1920. A corresponding area on the north bank, including the districts of Itacoatiara, Urucará, and Silves, had 24,910 inhabitants.

According to the census of 1920 the population of the Acre territory was 92,379, divided as follows among the different administrative units: Cruzeiro do Sul, 15,490; Rio Branco, 19,930; Senna Madureira, 21,141; Villa Seabra, 20,421; Xapury, 15,397. These districts correspond to the five principal towns of the territory and their tributary country. Of the five Seabra and Cruzeiro do Sul are in the basin of the Juruá, and the other three in that of the Purús. The population was 1.6 per square mile.

FIG. 4

FIG. 5

FIG. 6

FIG. 4—Santarém, at the mouth of the Tapajóz, one of the most flourishing towns of the Amazon Valley.

FIG. 5—Monte Alegre, on the left bank of the Amazon, State of Pará. Part of the town is built on the water front; part on bordering heights (see Fig. 16).

FIG. 6—Floods on the Tapajóz.

FIG. 7

FIG. 8

FIG. 9

FIG. 7—Serury, on the Rio Purús, one of the richest rubber-producing regions of the Amazon.

FIG. 8—Porto Velho, the downstream terminus of the Madeira-Mamoré Railroad, built to avoid the 200-mile stretch of rapids.

FIG. 9—Rio Branco (the former Bolivian village of Empreza), the capital of the Federal Territory of the Acre.

This rate is over three times that of the state of Amazonas and nearly four times that of Matto Grosso. Nearly all the rural population is engaged more or less directly in the rubber industry or is at least dependent on it for livelihood.

Only a general estimate can be made of the total population of the montaña regions of Peru, Ecuador, and Colombia, that is of the parts of those countries lying within the tropics of the Amazon Basin. Boundaries are either vague or are matters of active controversy, and up-to-date and reliable census records are nonexistent, so that the only basis for estimating the population is the scant local data available. Moreover, in the present state of development anything approaching a scientific census is out of the question. The Peruvian Department of Loreto, which is the most important administrative unit in the region under discussion, was estimated by the Geographical Society of Lima in 1896 to have a population of 100,596. At that time the Department of Loreto contained the two provinces of Moyobamba and San Martín, which have since been detached to form the new Department of San Martín. In 1896 the two provinces in question had an estimated population of 59,187, leaving a total of 41,409 for the rest of the department. Since that time only arbitrary personal estimates have been made. The average of such estimates as are within the realm of probability is about 60,000 for the entire department, exclusive of uncivilized Indians, whose numbers are variously given at from 60,000 to 100,000. These estimates include the population of the territory disputed between Peru, Ecuador, and Colombia, whose extent is ill-defined.[4] Most of the white and mixed population is concentrated in a narrow belt along the Amazon-Marañon, as far as the mouth of the Huallaga, along the Huallaga from its mouth to the vicinity of Chasuta, and in the zone bordering the Ucayali. The Tarapoto and Moyobamba districts of the Department of San Martín are also relatively well populated. The Indian population is heaviest in the country to the north of the main river.

To the south there are probably about 25,000 in those parts of the Departments of Cuzco and Madre de Dios in which rubber is found.

The latest Ecuadorian statistics give the population of the Province of Oriente at 100,000. The most recent Colombian figures put the population of the "Commissaries" of Caquetá, Putumayo, and Uaupés at respectively 74,254, 40,770, and 5500; but these statistics are undoubtedly greatly in excess of the actual population of those sparsely settled regions.

It may be very roughly estimated that the total population of those sections of the three countries in which rubber is found or is capable of being grown is between 200,000 and 250,000. This excludes the non-Amazonian parts of those countries, where tropical conditions prevail, as in the coast districts of Ecuador.

[4] Cf. R. R. Platt: Present Status of International Boundaries in South America, *Geogr. Rev.*, Vol. 14, 1924, pp. 622–638.

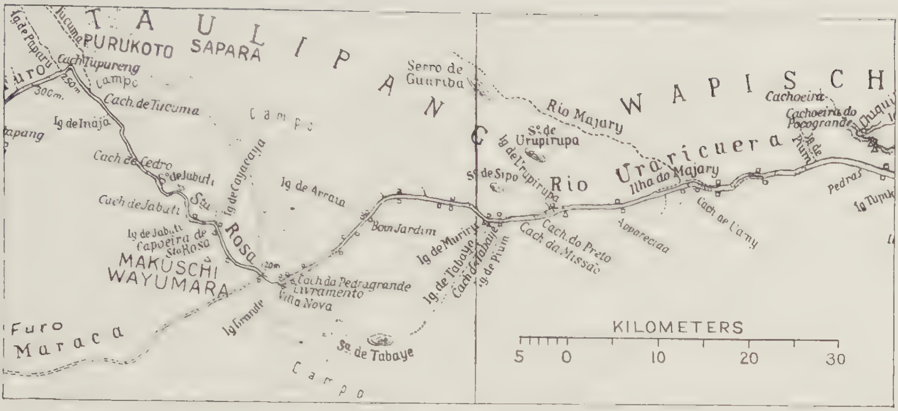


FIG. 10

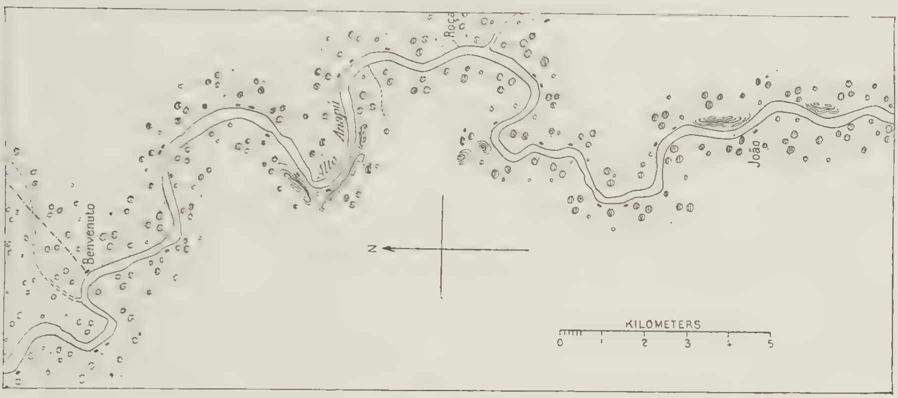


FIG. 11

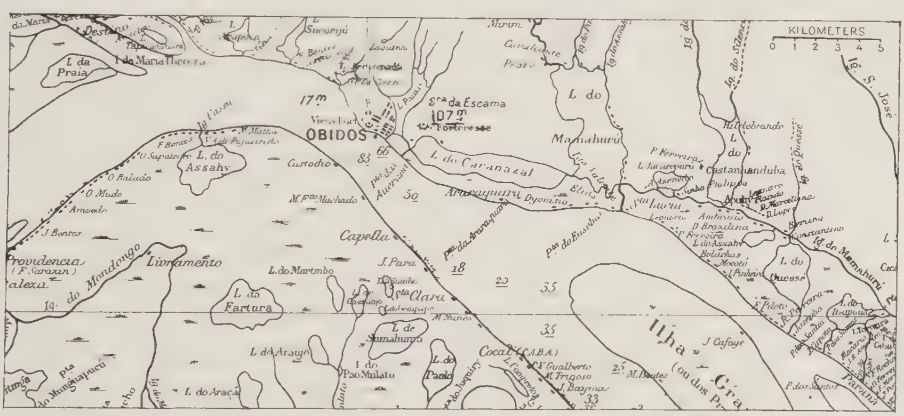


FIG. 12

FIGS. 10–12—Characteristic riverine settlement in the Amazon Basin. Compare the type figure on p. 69 of Brandt's "Kulturgeographie von Brasilien" (Stuttgart, 1922).

Figure 10 is from the route map in Koch-Grünberg's "Vom Roriama zum Orinoco, Vol. 1, 1917. It shows a portion of the Rio Uraricuera. The small squares indicate white, the triangles, Indian, settlements.

Figure 11 is a part of the Rio Anapú from H. Coudreau's "Voyage entre Tocantíns et Xingú," 1899.

Figure 12 shows the Amazon about Obidos from P. Le Cointe's "Carte du Bas Amazone de Santarém à Parintins," 1911.

It would appear probable that the population of the tropical part of Bolivia in which rubber is native or where its cultivation is practicable is about 100,000. According to the official census returns of 1900 the population of the Territory of Colonias was 6883. At the same time the Department of El Beni was credited with having 25,119 inhabitants, and Santa Cruz with 151,062. In 1918 an official estimate gave the following figures: Colonias, 49,761; El Beni, 50,265; Santa Cruz, 327,382. However, estimates of such scattered populations as those of Colonias and the Beni can only be more or less distant approximations to the truth. An estimate prepared for the American Rubber Commission by a special committee of prominent citizens of Riberalta calculated the population of Colonias at 20,000 and of the Beni at 30,000, including 5000 in the province of Vaca Diez. These figures, from casual observation, would appear reasonably accurate. Captain Felipe Rivera, the army officer in charge of the topographical survey of the territory, and who had unusual opportunities for observation, estimates the population of the important sector between the Manuripi-Orton-Beni and the Acre-Rapiarrán-Abuná at from 8000 to 10,000. This estimate corresponds to the years 1918–1920, which were spent in that region. The distribution of this population by nationalities of origin was approximately as follows: Bolivians, 25 per cent; Brazilians, 35 per cent; Peruvians, 10 per cent; Syrians, 8 per cent; Europeans, 5 per cent; Japanese, 2 per cent; miscellaneous, 15 per cent.

Of the cities of Amazonia, Pará, the largest, has an urban population of about 180,000. The municipal district of Belem, in which the city is located, had a population in 1920 of 236,402. Manáos, capital of the state of Amazonas and commercial metropolis of the upper Amazon country, has some 40,000. Its municipal district was credited by the census of 1920 with 75,704 inhabitants. Iquitos in Peru probably has between 8000 and 9000. Santarém, located at the mouth of the Tapajóz, has about 5000 or 6000, somewhat more than the population of Cametá on the lower Tocantíns, and Obidos has in the neighborhood of 3000. The other more important places, such as Riberalta and Cobija in Bolivia, Yurimaguas in Peru, Porto Velho on the Madeira, Teffé and Itacoatiara on the Amazon, Altamira on the Xingú, and Rio Branco and Cruzeiro do Sul in the Acre, have populations ranging from 1000 to 2000, though Riberalta probably has more. Few towns give evidence of any vitality, and the majority are in frank decay. Among places from which life has departed are Nauta in Peru, São Paulo de Olivença on the upper Amazon, Labrea on the Purús, and Gurupá on the lower Amazon.

Racial Composition of the Population

The great mass of the population of Brazilian Amazonia is of mixed blood, the product of various degrees of mixture of the original Portuguese settlers with the native Indians and the descendants of negro slaves. The

rural population is commonly known by the term "caboclo," though different names may be applied to the various classes of mixtures, as "tapuyo" for the crossbreed of white and Indian. Among the native population of the states of Pará and Amazonas the Indian element predominates over the negro in the admixture, though both elements may be encountered everywhere in greater or less degree. In Matto Grosso the negro is an entirely negligible factor in miscegenation. The Cearenses, or immigrants from the state of Ceará, who constitute an especially important element in the Acre territory, are a mestizo people, that state not having been the

FIG. 13

FIG. 14

FIG. 13—The Bolivian town of Riberalta occupies a favored site on a bluff at the junction of the Beni and the Madre de Dios.
FIG. 14—Itamaraty on the Abuná.

seat of industries dependent on negro slave labor. However, the immigrants from the states of Maranhão and Piauhy, who also constitute a numerous section of the population in some districts, have a considerable admixture of negro blood. This is true of a large part of the population in the zone about the city of Pará.

The pure Indian is of steadily decreasing importance in the racial makeup of the Amazonian population. The more amenable tribes tend to lose their identity through miscegenation or other peaceful processes. Thus, many tribes like the Maués of the state of Amazonas and the Huitotos of the Putumayo country, are now classed as "mansos," or civilized. The less pacific or more helpless peoples are gradually being exterminated by intertribal strife or in clashes with the rubber gatherers, and disease has also taken a heavy toll among some of these folk. During the time of the great rubber boom the Indians were often relentlessly hunted, either as labor material or as irreconcilable opponents of the invaders of their tribal

lands. This occurred on a large scale in the valley of the Javary, in the Acre country, and in the Itenez basin in Bolivia, where the population is said to have been decimated in the search for laborers for the *gomales* or rubber forests of the Beni. Important peoples, like the Caripunas of the Madeira, have been greatly reduced in numbers and no longer appear on the rivers, as they were formerly wont to do. The process of extinction has been at least retarded by the work of the famous Rondon Commission in Matto Grosso, which has brought such numerous tribes as the Nhambiquaras under its supervision. Other agencies, governmental and religious, are working to the same end. Among these may be mentioned the post of the federal Indian Protection Service in the Pauhiny section of the Purús basin and the Benedictine mission stations in the upper Tapajóz country.

Scattered tribes of savage Indians still exist in spite of all the conditions operating against their survival. Among such are the robust Parintintíns of the great wilderness to the west of the Madeira, the Assurinís of the right bank forests above the "Great Bend" of the Xingú, the Huambizos and Aguarunas of the upper Marañon lands in Peru, and the Cashipos of the Pachitea valley in the basin of the Ucayali.

Very few of the class of rural laborers are white. The whites are largely restricted to the large towns and to the class of landed proprietors. There are a considerable number of Portuguese, engaged in business and in the trades, and there are small Italian colonies in the larger cities. An American colony, founded near Santarém by immigrants from the southern states during the Reconstruction Period, now consists of only a few scattered families, of which the second generation has been well Brazilianized. Two recent attempts at the colonization of parts of the Ucayali basin in Peru by Americans have failed completely.

Though unimportant in the aggregate, the Syrians are a ubiquitous element in the Amazonian population. Popularly known as "Turks," they are found everywhere as traders, either established in the towns or traveling up and down the rivers as itinerant merchants. In some places, as at Rio Branco in the Acre, they almost monopolize the retail business, and at Pará they have a few very important commercial houses. Though frowned upon by the native business class, they manage to flourish and tend to form Brazilian families through intermarriage with women of the country.

There has never been any considerable immigration of Orientals into the Amazon Basin. Most of those who are found there came down into Bolivia from Peru by way of the Madre de Dios. The Suarez rubber properties have employed as many as 300 to 350 at one time, and other landowners have also used them. However, most of these Japanese abandoned the rubber forests because of the decreased remuneration offered by the proprietors. Many have settled in the towns, including about 300 in Riberalta and a large colony in Trinidad, where for the most part they have either monopolized the local business of small shopkeeping or work

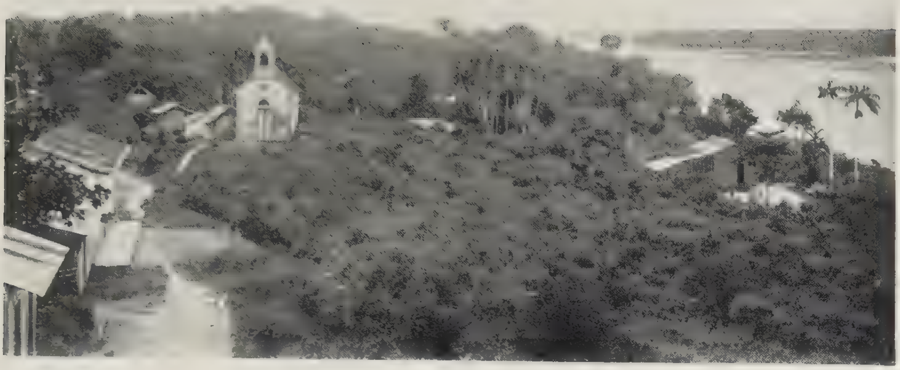


FIG. 15

FIG. 16

FIG. 15—S. Paulo de Olivença, on the right bank of the Solimões.
FIG. 16—Monte Alegre. Part of the town is built on the slopes of a sandy plateau rising some 70 kilometers above the river (compare Fig. 5).

as truck gardeners, barbers, tailors, and at other trades. They generally form native households that are prolific in sturdy children. The number of Chinese in Bolivia is insignificant, but in Peru they constitute a very important class of retail traders.

Factors Affecting the Distribution of Population

Proximity to a navigable river is one of the principal factors determining the distribution of population in the Amazon Valley. There, in lieu

Fig. 17—Manacapurú on the Solimões, a short distance above Manáos.

of trunk roads and railways, rivers are the main arteries of communication, and settlement centers on their banks for facility of transportation, as well as for the feeling of connection with the outside world that comes from the more or less frequent calls of steamers. Moreover, the rivers are fruitful sources of food, either of turtle meat or of the *pirarucú* or other fish.

The Amazon and its important tributaries have regular lines of steamers that ply to their limits of navigation. This point is usually determined by the first rapids; but where rapids are absent, as in the Purús or the Juruá, the limit of navigation is pushed much farther up the rivers during the rainy season. The Purús, for example, rises from 40 to 50 feet between December and March, so that remote points on the upper reaches of its system are then accessible directly from the Amazon. Places that can then be reached in a few days may be weeks distant by canoe from navigable water during the dry season. The remote rubber fields of the upper Acre, of the Gy-Paraná or Machado above its *caxoeiras*, or of the São

Manoel in Matto Grosso are representative examples of the long isolation of the dry months.

The sites chosen for settlement are generally on *terra firme*, or high land, well above the flood level of the rivers. Among the few towns subject to frequent flood are Trinidad in the Mojos Plains of the Beni and Benjamin Constant (Remate de Males) on the Javary. Some, like São Paulo de Olivença and Fonte Boa on the Solimões and Riberalta on the Beni, are situated on especially high ground. San Pablo and Sena, two important establishments on the Madre de Dios, are situated about 300 feet above

FIG. 18—A house on the road to Tres Casas, Rio Madeira.

the river. On rivers like the Purús settlements are generally located on *barrancas*, or bluffs, where the great bends of the river skirt the edge of the *terra firme* on either side, as the stream meanders across its wide flood plain. Where houses are located on so-called *varzea* land, that is ground subject to inundation, they are often raised on a platform so that the floor is above the level of all but extraordinary floods. However, such exceptional deluges as have lately ravaged the banks of the lower Amazon over a number of years upset all calculations founded on years of security and struck a serious blow to long established agricultural communities, like those of the Paraná of Obidos.

Another reason for avoiding low ground as sites for settlement is the greater risk from malaria. The association of malaria with swampy or ill-drained land is now generally comprehended by the natives; but many of the old *barracões*, or establishments, on the Madeira and the Purús are located on land that is infested with mosquitoes. More often than not the mosquitoes are not of the Anopheles variety, but nevertheless they

constitute a burden to the life of the inhabitants. One settlement on the Madeira bears the significant name of Carapanátuba, the *lingua geral* for "many mosquitoes." Parts of the lower Ucayali basin and of the low Mojos prairies in Bolivia are rendered almost uninhabitable by mosquitoes. Epidemics of malaria in malignant form occasionally ravage the population of certain streams and lead to an exodus of the population to more healthful localities.

Another important factor in determining the course of population is an economic one—the opportunities offered for earning a living. Dependence on the extractive industries has tended to attract population always farther into the interior, particularly when prices of the products sought have been high enough to justify the extra effort required in opening up new and more fruitful areas. In the introduction to this paper reference was made to the importance of the quest for rubber as a motive force in the settlement of the Amazon Valley. Certainly this was true before the collapse of the great rubber boom after 1910. For about two decades previous to that there had been a fairly steady movement of population up the southern tributaries of the Amazon in search of new stands of the coveted *Hevea brasiliensis*. There were also movements of a similar character down the remote upper rivers from the side of Bolivia and Peru. Bolivians flocked into the Beni basin from the Santa Cruz country or from the valleys of the sierra, and Peruvians occupied the lands between the Huallaga and the Javary, crossed the Amazon into the Putumayo valley, and penetrated across territory disputed with Colombia to the distant Caquetá.

Interesting references to the movements of the rubber gatherers in Matto Grosso are given in the reports of the Rondon Commission. On the Rio Roosevelt the *seringueiros* coming upstream had penetrated as far as latitude 10° 24′ S. by 1914; on the Juruena to 8° 20′; on the Telles Pires (1915) to about 9°. The commission further notes the existence of a "no man's land," 300 to 500 kilometers broad, separating the rubber gatherers of the northern part of the state dependent on Manáos and Pará from a belt in the center of the state dependent on the city of Matto Grosso.[5]

One of the most interesting types in the Amazon Valley is the Peruvian *cauchero*. While this class includes large numbers of Brazilians, the Peruvian *cauchero* has a special fame throughout Amazonia. These men are workers of the class of rubber known as *caucho*, the product of the *Castilla elastica*. In contrast to the process of tapping the *Hevea*, whose exploitation constitutes a more or less settled industry, the working of *caucho* demands a nomadic life. This is due to the fact that the trees are cut down in order to extract the latex, forcing the *caucheros* to keep up an endless search for new stands of the *Castilla* tree.

[5] For a summary see Pierre Denis: Résultats géographiques des explorations du colonel Rondon au Matto Grosso, *Ann. de Géogr.*, Vol. 33, 1924, pp. 46–65.

Brazilians worked far up every river from the Tocantíns west to the boundaries of Peru and even searched the forests of the northern rivers for "weaker" grades of rubber, the *Hevea brasiliensis* being confined to the south of the Amazon, save for a small zone on the left bank of the Solimões. The outstanding episode of this great movement was the occupation of the Acre, then under the rather vaguely asserted sovereignty of Bolivia. Settlers from Brazil, chiefly Cearenses, ascended the Purús or

FIG. 19—Cattle on the campos of the upper Rio Branco, the southern extension of the great grasslands of the Orinoco basin.

the Juruá, took possession of the lands along the upper rivers, and carried out a separatist movement similar to that which led to the annexation of Texas by the United States. The Acre, the classical rubber land, thus became by the Treaty of Petropolis in 1903 a federal territory of Brazil.

The Cearenses, who played so prominent a part in the settlement of the Acre, are an adventurous element, of great initiative, and given to roving when once detached from the native habitat of their inhospitable state. The periodic drought to which Ceará and the adjacent states of northeastern Brazil are subjected has been a powerful contributor to the population and exploitation of the Amazon. The first great influx of Cearenses to the region was a result of the terrible drought of 1877–1879. Every succeeding drought has been followed by an exodus from the affected territory. In 1916 according to M. Le Cointe[6] between 8000 and 10,000 Cearenses arrived on the Amazon, most of them destined for the *seringaïs* of the upper river. Even with the decline of rubber exploitation on the Amazon new workers have been needed, for the industry has proved exceedingly

[6] *Op. cit.*, Vol. I, p. 379.

wasteful of human life. Writing in 1913 Dr. Oswaldo Cruz said: "On the rivers Acre, Abuná, Kapury, and others, the destruction of human life attains exceptional proportions." Since then, however, conditions have greatly changed for the better. The Acre today may be considered one of the most healthful parts of the Amazon Valley.

The Cearenses are disposed to return to their native state when opportunity offers. However, many have identified themselves permanently with the localities which they have done so much to develop. Considerable numbers have penetrated into Bolivia from across the borders of the Acre and by way of the Abuná. In this connection I recall an incident that took place while crossing from Cobija on the Acre to the Suarez rubber post of Porvenir on the Tahuamanu. On observing some persons engaged in the preparation of manioc flour we inquired whether it was "yuca" or "mandioca," respectively the Bolivian and Brazilian words for manioc, and received the reply: "E mandioca, e somos cearenses."

After the sensational crisis that followed the high prices of 1910 there ensued an exodus from all the rubber districts. Men flocked down to Manáos and Pará by the thousands, and large numbers returned to drought-ridden Ceará and the other northeastern coast states. The same fate befell all the upper rivers, and some regions, such as the country above the rapids of the Tapajóz, were nearly depopulated. The rubber industry in Peru almost ceased to exist, its place being taken by the collection of gutta percha and tagua nuts and the cultivation of cotton in the Ucayali basin. There have been occasional recurrent movements into the Brazilian rubber districts, whenever prices have again reached a sufficiently remunerative level, but none of the movements have attained anything approaching the magnitude of the great exodus of 1912. Early in 1924 we saw one steamer laden with over 300 rubber workers from the Juruá, when the price of rubber was hovering around two milreis per kilo in Manáos and Pará.

In certain regions the gathering of castanha, or Brazil, nuts has superseded in importance the traditional rubber industry. This is largely in the nature of a seasonal occupation, the gatherers being recruited in other districts for a short period and returning to their homes after the crop is harvested. Owing to good prices this industry has flourished of late on the northern rivers from the lake country of Anajá and Codajaz in the zone of the Solimões east to the Parú and the Jary, and over a wide area to the south of the Amazon, culminating in the valley of the Tocantíns. Consequently there has been a large annual ebb and flow of population between the *castanhaes*, or Brazil-nut forests, and older settlements along the main rivers.

A similar movement has been the influx of laborers into the balata-yielding forests of the Rio Branco basin north of Manáos. However, the majority of these workers return to Manáos at the end of the tapping season, unlike the rubber workers, whose tendency is increasingly to remain

on the property throughout the year. This is in part due to the double circumstance that the working of balata has been so profitable that no one could be induced to devote his efforts to the production of foodstuffs in that region and that the comparatively large income made by the workers tempted them to go to Manáos to spend their *saldo*, or balance.

The ease with which land may be acquired also has an influence on the distribution of population. Much public land is still available in certain localities, but the more accessible lands have generally been occupied long since, as has occurred in the Acre. The various state governments are usually lenient with squatters on state lands, when the intention of serious settlement is evident, and tend to allow the validation of such rights, or "direitos de posse," as they are known in Brazilian law. The land laws of the three Brazilian states, as also of Bolivia and Peru, make generous provision for the acquisition of homestead properties.

Real settled communities exist only in a few localities. Among them are those which supply the cities of Pará and Manáos with such primary foodstuffs as corn, beans, and rice, the cultivators of *guaraná* (a shrub whose seeds are used in the preparation of a stimulating drink) in the Maués country, the cacao growers below Obidos and on the lower Tocantíns, the owners of small rubber plantations about Boim and Aramanahy on the lower Tapajóz, and the cotton growers of the Ucayali in Peru. Dependence on a local food supply has done much towards fixing the population in certain regions, as in the Acre, which has gone far towards self-sufficiency in this respect. The Acre now produces nearly everything that it eats, and as a result of this condition the inhabitants tend to remain on the land when the price of rubber makes its working less remunerative, rather than abandon the *seringal* for Manáos or Pará. The same tendency is noticeable in other localities, as in Bolivia and on the lower Purús. Under this new régime during the season when the tapping of the rubber trees is suspended or relaxed the *seringueiros* dedicate themselves to the cultivation of beans, corn, rice, manioc, bananas, and sugar cane. Fish are also caught and salted, and pigs and chickens are raised. This is contrary to the old system, whereby the proprietor discouraged the production of foodstuffs by his workers, because of the profit which he made on their sale and because he preferred that the *seringueiro* devote all his time to the production of rubber. A few proprietors have clung to the old system, but the majority have accepted the new conditions as more advantageous to all concerned.

THE JAMES BAY COASTAL PLAIN

NOTES ON A JOURNEY*

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The wide, flat, horseshoe-shaped plain which borders James Bay has been known to the old French *coureurs de bois* and the *vogageurs* of the fur companies since 1662, when the two Frenchmen, Radisson and Groseilliers, reached James Bay via the Moose. But it still belongs to the domain of the fur trader and the Indian and remains as little known to the general public as the far Northwest. However, a railway to James Bay is now under construction by the Ontario government. When it is completed it will be but a day's journey from Ottawa to Moose Factory, Ontario's undeveloped northern seaport. The route which has been surveyed for the James Bay railway leaves the Canadian National line at Cochrane and follows the general direction of the Abitibi River, reaching tidewater at Moose Factory. Seventy miles of track have been laid on this line.

North of rail-end the canoe route is still the only road to the coastal plain and the sea. The journey is usually made by one of the three largest rivers of the region south of James Bay, the Abitibi, the Mattagami, and the Missinaibi. The first-named is the shortest and is generally preferred. Supplies for the trading posts at Moose Factory are frequently sent from the railway via the Pagwachewan and Albany River route which, though much longer than the Moose River routes, is without portages or rapids of consequence. All of the other canoe routes to the Bay involve numerous portages and the running of rapids which require skilled canoemen.

The Abitibi River was traversed by the writer on the north-bound trip to the Bay. A thirty-mile cruise was made up the James Bay shore before starting on the return journey, which followed the Missinaibi River and ended at Mattice, October 3, 1923. The nearest good harbor to Moose Factory is Charlton Island. Here supplies arriving by sea are transferred to schooners or other small craft capable of threading the channels about the mouth of Moose River. The difficulties of securing deep-water approaches to Moose Factory, if it should ever develop as a port, are comparable with those which have been overcome at the harbors of La Plata and Buenos Aires in the Argentine Republic, where the harbor approaches are for many miles through depths of from one to four fathoms.

A broad belt of relatively high land, known as the "clay belt" rims the southern border of the James Bay coastal plain. The topography of the clay belt through which the Canadian National railway runs closely approximates that of northern Ohio and the Ontario peninsula. The hilly preglacial

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surface has been deeply buried by glacial till, which shows a flat or slightly rolling surface 750 to 950 feet above sea level near the railway. The clay belt offers the most extensive area of good farming land for future colonization on the Laurentian Plateau. Since the construction of the railroad considerable agricultural development has already taken place there.[1]

North of Cochrane, in the clay belt, settlement and agricultural development have extended 13 or 14 miles. West of Cochrane, along the Canadian National line, settlement of the land has extended a much shorter distance from the railway. On Missinaibi River the untouched forest reaches to within a mile of the railway. A well-equipped Dominion experimental farm is located at Kapuskasing.

In the northern part of the belt, 30–60 miles north of the Canadian National railway, there is a strip of country where the rivers are characterized by numerous falls and rapids. The Abitibi River canyon and other localities on this river afford promising sites for water power. In crossing this belt to the coastal plain the grade of the Abitibi rises to 36 feet a mile for six and a half miles, while the grade north and south of it is respectively 3.4 and 5 feet a mile. The accelerated grade in the Abitibi River in the vicinity of the canyon is rather closely paralleled by that found in other branches of the Moose west of it.

The Topography of the Coastal Plain

The scarplike northern margin of the clay belt delimits the southern border of a very youthful plain that has emerged from the sea since the postglacial submergence. The slope of the plain is remarkably uniform, amounting to 3.4 feet a mile along the Abitibi and Moose Rivers. Its width is from 75 to 100 miles in the basin of the Moose River; it is still wider toward the northwest in the basin of the Albany River and continues to Cape Henrietta Maria and beyond. According to W. J. Wilson, "the country is as flat as it can be"[2] along the Kapiskau River, northwest of the Albany River, for 175 miles. On the eastern side of James Bay the coastal plain narrows toward the north and disappears. Near Cape Jones at the northeastern corner of the bay the plain gives way to high land, which rises near the shore from 1000 to 2000 feet above the sea[3] between Cape Dufferin and Cape Jones. The land is low on the eastern side of James Bay with a gentle slope as far north as East Main River, where the elevation 100 miles inland is only 700 feet.[4]

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[1] Helge Nelson has clearly described the climatic and other factors controlling the agricultural development of the clay belt (Interior Colonization in Canada: *Geogr. Annaler*, Vol. 5, 1923, pp. 275–289, Stockholm). See note in this number of the *Review*.

[2] W. J. Wilson: Reconnaissance Surveys of Four Rivers Southwest of James Bay, *Canada Geol. Survey Summary Rept.*, Vol. 15, 1902–03, pp. 222A–243A; reference on p. 225A.

[3] Robert Bell: The Labrador Peninsula, *Scottish Geogr. Mag.*, Vol. 11, 1895, pp. 335–361; reference on p. 338.

[4] A. P. Low: Report on Explorations in the Labrador Peninsula, etc., *Canada Geol. Survey Summary Rept.*, Vol. 8, 1895, pp. 5L–387L; reference on p. 22L.

FIG. 1—Hudson Bay post at Moose Factory. The photograph shows islands in the estuary of the Moose River where the width is about 2½ miles. (Photograph by the Fairchild Aerial Surveys Company [of Canada] Ltd.)

FIG. 2—View showing Fort Albany and heavily forested island back of it. The straight lines represent surveyors' lines cut through the forest. (Photograph by the Fairchild Aerial Surveys Company [of Canada] Ltd.)

The seaward margin of the coastal plain is seldom well defined. Its location varies from day to day according to the height of the tide, which depends largely on the strength and direction of the wind. A north wind may

FIG. 3—Sketch map of the James Bay region. Scale approximately 1: 6,500,000.

raise it nearly twice its normal height, and a south wind can reduce it in like degree. A strong wind from the sea may push the shore line inland a half mile or more from the position it occupied during a period of calm weather, while a breeze from the land may hold the flood tide far to seaward of its average position.

The coast line presents from the sea an intensely monotonous aspect. West of the Moose River it appears to trend away northwestward without

indentation. Bays ten or fifteen miles long and a mile wide make no appeal to the eye. The land is entirely without relief, and twelve miles from shore it becomes invisible. Traveling by canoe at high tide one gets the impression of voyaging over the surface of a huge saucer filled to the point of overflowing. No one familiar with this coast is likely to disagree materially

FIG. 4—Islands in the Albany River near the sea margin of the coastal plain. (Photograph by the Fairchild Aerial Surveys Company [of Canada] Ltd.)

with Magistrate Borron's estimate of its defects from the standpoint of the *voyageur*, which he stated thus:

> The shallowness of the water, the number of boulders, the dearth of harbours or shelter of any kind, the impossibility of either going ashore or embarking again without wading, sometimes long distances, the poorness of the camping grounds, and scarcity of both fuel and fresh water, are the cause not only of delay, but the source of constant anxiety and discomfort to the *voyageur*.[5]

The writer found an abundance of fuel in stranded logs and of fresh water; but this no doubt, was largely a matter of luck.

At low tide the sea retreats from two to six miles or more from the high-tide shore line. The broad intertidal zone which is thus laid bare at low tide appears to the eye quite flat. It is floored generally by rather firm, well rippled, sandy silt or clay which is plentifully sprinkled with glacial boulders. An occasional *Fucus* attached to a pebble is seen on this intertidal bottom.

[5] E. B. Borron: Reports of the Stipendiary Magistrates with Respect to the Northerly and Westerly Parts of the Province of Ontario, Legislative Assembly, Ontario, 1882, p. 43.

A fine green grasslike plant one to one and a half inches high covers much of the intertidal bottom at many localities and extends over the regularly submerged zone often several hundred yards from shore. Mussels and two or three other shells are common and widely distributed over this zone.

Along the landward margin of the wide intertidal belt runs a neutral zone debated between land and sea. Pools of salt or brackish water only a few inches deep and from 2 to 60 yards in diameter occupy most of this area. About a quarter of these panlike basins have forming on their bottoms a slimy black mud which is associated with green salt-water algae and may be a by-product of its metabolism. Landward this salt-pond zone passes into a belt where the high tides only rarely reach, and here the dry bottoms of the shallow panlike depressions are beautifully mud-cracked.

The salt-pond zone with its very sparse halophytic vegetation merges into a zone slightly higher where the ponds are scarce or absent and the surface is clothed with a dense growth of marsh grass often making natural hay land. This zone is capable of furnishing an abundance of wild hay. Cattle kept at Moose Factory are supplied with hay from this source. Marshy spots in this zone support colonies of cat-tails and other fresh-water plants, and fresh-water molluscs are very abundant in some of the small shallow fresh-water basins in this zone. Patches of dead cat-tail, the absence of trees, and occasional pieces of driftwood point toward marine invasions at rather widely spaced intervals.

The forest zone is separated from the prairie zone by a belt of straggling willows. The willow zone with other shrublike trees forms the outer border of the spruce forest which everywhere lies a short distance back of the prairie zone.

Glacial boulders, which have doubtless been dropped by stranded ice, are much more abundant on the normal intertidal zone than on the brackish pond zone adjacent to it, thus suggesting a longer period of sea-level stability at its present position than it experienced when the zones now inside the intertidal zone were submerged. Patches of clay and stones left by stranded ice are occasionally seen on the salt-pond zone.

The featureless character of the coast continues on beyond the Albany River, as the following description relating to the mouth of Chikeney Creek will indicate:

> At that point, the woods are about three miles back from the average high-tide mark. Between the forest and the tide mark is an open, level plain, the first mile of which is covered with scrubby willows. The other two miles support a growth of luxuriant grass. This grass gradually gets thinner as it approaches the water until at last only scattered bunches of it remain. Between the extremes of high and low tide a space of about three miles of soft clay mud intervenes; this is also perfectly flat and covered with small boulders. On the mud when the tide is out lie shallow pools of salt water. From the last bunches of grass it is hardly possible at low tide to see the open water.[6]

[6] A. R. M. Lower: A Report on the Fish and Fisheries of the West Coast of James Bay, in "Repts. on Fisheries Investigations in Hudson and James Bays and Tributary Waters in 1914," Dept. Naval Service for year 1914, p. 39.

Fig. 5

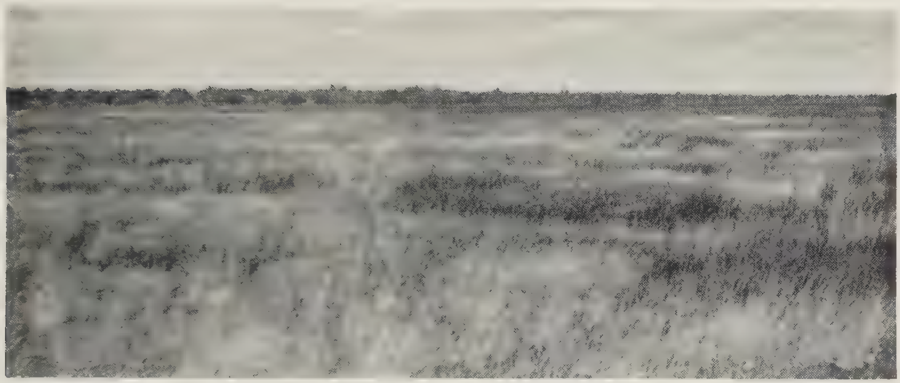

Fig. 6

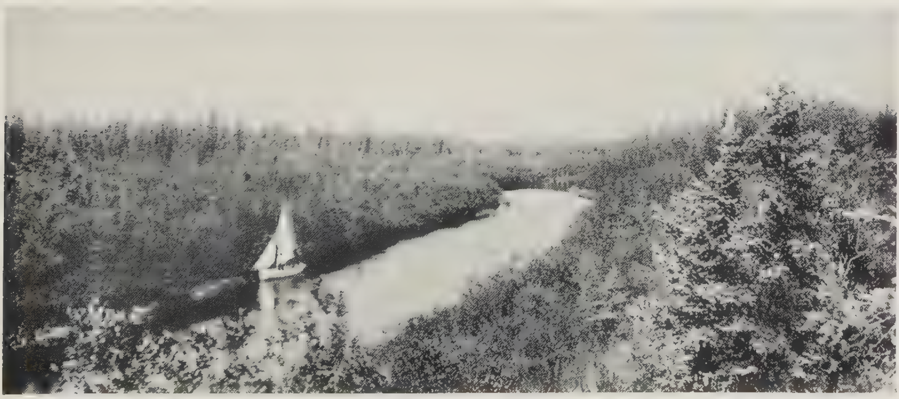

Fig. 7

Fig. 5—The tide pool or sea margin zone of the coastal plain.
Fig. 6—The prairie zone just inside the zone of mud-cracked tide pools.
Fig. 7—The spruce forest zone which lies on the inland side of the willow zone inland.

The sounding line has shown that nearly the same monotonous seaward slope that characterizes the land continues under the sea as far as the middle of James Bay. The sea-bottom grade from shore toward the middle of James Bay runs generally between two and three feet a mile. There are few coast lines where the sea-bottom grade is so low. Most of the coast of Holland, which is noted for shoal water, has a steeper seaward grade than James Bay; but the stretch of sea bottom west of the Zuider Zee, known as the "Broad Fourteens" is comparable with the southern part of James Bay in depth and grade. It recalls also the Rio de la Plata embayment on the South American coast, where the depth over an extensive area rarely exceeds ten fathoms.

The general uniform flatness of the James Bay sea bottom is broken by bars and well defined channels around the mouth of the Moose. The uniformity of bottom also fails between the large island of Akimiski and the mainland. The four daily high tides characterizing this channel produce strong currents, which trench a part of it to a maximum depth of 18 fathoms.[7] The splitting of tidal currents in James Bay responsible for the "Cock" and probably other gravel bars on the coast is shown in Lower's diagrammatic chart.[8]

The Albany River shortly before it enters the bay wanders among a maze of islands, as shown in Figure 4. The deep trenchlike cutting through the heavily forested island in the left foreground which may have developed during an ice jam, probably represents a preliminary stage in the slicing of this island into two parts. Such trenches are not uncommon in the islands of northern rivers composed of alluvial or other unconsolidated beds.

The lower 18 miles of the Moose River has a width of from three to three and a half miles where it spreads among numerous islands. It narrows to half that width at a distance of 25 miles from the coast. The appearance of the river near its maximum width as seen from the air at Moose Factory is shown in the photograph, Figure 1. The banks of the Moose, which stand at high tide only a few inches above the water at the mouth of the river opposite Shipsand Island, rise to 18 or 20 feet above high tide eight miles up stream. Along the Missinaibi branch, ten miles above its junction with the Mattagami, the bank stands 30 to 45 feet above the river. Near the southern margin of the coastal plain the streams are incised still more deeply. At the junction of the Wabiskagami the stream is cut 100 feet or more into the level plain.

The coastal-plain channels of the rivers show a somewhat definite correlation between height of bank and width of stream where the materials are of uniform character, like the glacial drift or marine clay. Along a stretch of the Missinaibi where the height of bank changes from about 50 to 100 feet the width of the river, within the higher banks, is reduced by about

[7] Lower, *op. cit.*, p. 42.

[8] *Ibid.*, p. 67.

half. The grade of these rivers is too high to permit much swing or meander development, and they tend to keep fairly direct channels.

Climatic Conditions in the James Bay Region

The summer and fall temperature of the coastal plain would appear to be somewhat more favorable than is commonly imagined. The average temperature at Moose Factory for the summer months is very close to that recorded for Calgary, Alberta. The ten-year mean of the two localities for August is identical, and for June, July, and October it differs by only one degree. These two widely separated points in nearly the same latitude show greater contrasts in winter temperatures, as the following table indicates:

Table I—Mean Temperatures at Cochrane, Moose Factory, and Calgary[9]

Month	Cochrane Lat. 49° N.	Moose Factory Lat. 51°15′ N.	Calgary Lat. 51° N.
January	0	−3	11
February	1	−2	14
March	16	11	25
April	33	28	40
May	46	42	49
June	58	55	56
July	64	62	61
August	59	59	59
September	51	52	50
October	39	40	41
November	24	24	26
December	8	5	20
Annual means	33	31	38

A temperature record kept during the trip to James Bay compared with Weather Bureau figures for Cochrane showed higher records for the points on the coastal plain. These figures appear to substantiate the opinion that the decrease in elevation in proceeding from the Height of Land and the clay belt to James Bay and proximity to that body of water more than compensates for the higher latitude in temperature control.

On the 12th, 13th, and 14th of September, 1923, a light snowfall occurred along the line of the Canadian National railway. At Kapuskasing nine inches of snow fell. In the Lake Superior district traces of snow were reported on the same dates over a distance of 676 miles along the Canadian Pacific railroad. A trace of snow was also reported from Ruel, located in the

[9] Frederic Stupart: Ann. Rept. Meteorol. Service, Canada, 1921. The record represents mean temperatures for a ten-year period. See also isotherm charts in Frederic Stupart: Climate and Meteorology, *Canada Year Book*, 1920, p. 164.

intermediate region between the two railways, and from some points east of Georgian Bay.[10] The failure of this widespread snowfall to extend north into the James Bay coastal plain is noteworthy in this connection. The temperature record kept during the journey shows, moreover, that there was no approach to snowfall conditions in the vicinity of James Bay.

The highest temperature in the coastal plain recorded on the trip was on September 26, when the noon and afternoon (between 5 and 8 P. M.) readings were 72° and 64° respectively. An exceptionally fine display of the aurora borealis was observed on the evening of this day, which is noted here because of the unusual temperature conditions associated with it.

Mr. Ward, agent of Revillon Frères at Moose Factory, states that he has observed a temperature of 99° inside his office, which has a southern exposure. The transient visitor, however, finds a good index of the coastal-plain climate in the luxuriant gardens kept by the Post managers and the Mission at Moose Factory. These show that all of the vegetables, including tomatoes, except corn and certain other heat-loving plants commonly grown in the Ottawa valley, do well in the Moose River valley except in the occasional seasons when summer frosts occur.

A number of late-blooming plants were seen in blossom throughout the latter half of September on the coastal plain. Five plants [11] in full bloom collected at Tom King rapids, Missinaibi River, on October 1 indicate that winter does not follow summer so precipitately in the James Bay region as is often supposed by dwellers in the south. More delightful weather than that encountered during the latter half of September on the coastal plain would be hard to find. The mosquito and black fly both disappear early in September, enabling one in early autumn to enjoy fully the mellow yellow tints of the poplars which deepen day by day. The forests never attain the brilliance however, of those of southern Ontario owing to the absence of the maple.

The first frost seen by the writer this season (1923) came on September 3, but it was too light materially to check the growth of the potatoes at New Post. In 1900 Niven and Burrows [12] report the first frosts observed by them on the James Bay slope to have occurred September 6 and 9. Ice usually closes the rivers early in November. The lower Abitibi is reported to have been open for canoes till November 19 in 1922. James Bay freezes over for a distance of many miles from shore in midwinter. It is reported[13] that snow melts and the rivers open during the latter half of April.

[10] Most of the data regarding this snowfall were supplied by the Dominion Meteorological Service.

[11] These were identified by Dr. M. O. Malte, Chief Botanist of the Canadian National Herbarium, as *Aster salicifolius* Ait.?; *Aster Lindleyanus* T. & G.; *Solidago hispida* Muhl.; *Solidago canadensis* L.; *Allium Schoenoprasum* L. var. *sibiricum* (L.) Hartm.

[12] Report of the Survey and Exploration of Northern Ontario, Legislative Assembly of Ontario, 1900, pp. 55 and 72.

[13] J. M. Bell: Economic Resources of the Moose River Basin, *Rept. Ontario Bureau of Mines, Part I*, 1904. p. 175.

EXPLORATIONS IN NORTHWESTERN ALASKA*

By Philip S. Smith
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In the preceding number of the *Geographical Review* Alaska is depicted as a land of potential resources.[1] Even these potentialities, however, are far from being fully known. There is, for instance, the case of the Naval Petroleum Reserve set apart in 1923, a tract of nearly 35,000 square miles of territory almost unknown except for a narrow fringe along the coast. The Navy Department, to whom administration was entrusted, requested the Geological Survey to explore the region and to prepare a report on its geographic and geologic conditions. In 1923 three parties, under the leadership of Sidney Paige, mapped much of the coastal portion, and in 1924 three other parties carried surveys into the southern part of the reserve and the adjacent country. Through these surveys and former investigations made by the Geological Survey in near-by areas the general characteristics of the country are now sufficiently well known to be described. The term northwestern Alaska, as here used, includes all of northern Alaska north of Noatak River (roughly latitude 68°) and west of the Anaktuvuk and Colville Rivers (approximately longitude 151°). In this tract about 25,000 square miles have been mapped, and in the remainder there are no points more than 40 miles distant from an area that has been mapped, and most are not as far away as 20 miles. In other words, practically all of the area has actually been seen, though some, of course, not in detail.

People and Settlements

Not only is the region practically unknown to the whites, but it is scantily populated by the natives. Except near the coast and near the southern margin of the mountains forming the southern part of the area, the region is entirely unsettled, and only rarely do even natives traverse the inland parts of the region. During the entire time our parties were in northwestern Alaska in 1924 not a person was seen from the middle of the Unakserak, a tributary of the Alatna, to a point within a few miles of the coast nor, after the Survey party left Wainwright, until it reached the school and mission on the Noatak. The large settlements are at Point Hope, Wainwright, Barrow, and Point Barrow, at each of which except the last named there is a school, a store, and many houses. Here and there between these places are smaller settlements of natives, and practically everywhere along the coast are indications of former human oc-

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[1] A. H. Brooks: The Value of Alaska, *Geogr. Rev.*, Vol. 15, 1925, pp. 25–50.

cupation, but these signs seem to have been made by traveling or hunting parties. In the inland part of the region the signs of former human habitation proved rare and were made long ago. Formerly, however, there were many natives in the back country, and parties traversed it for game and to reach the spruce that grows on the south side of the mountains.

According to a rough estimate, less than a thousand people now live in that part of Alaska north of latitude 68° and west of longitude 151°. Of these people, less than twenty are whites, and all the rest are at least part Eskimo. The whites are engaged principally in trading or in ministering to the needs of the natives, including the conduct of schools and missions and stores and, at Barrow, the maintenance of a well-equipped hospital. The natives spend their time chiefly in hunting or in assisting in the activities of the whites. Formerly whaling was carried on extensively, but the decline in the price of whalebone and the substitution of mineral oils for whale oil has so adversely affected this industry that at present it is almost dead. Even hunting is less actively carried on now than formerly, partly because game has become less abundant near the settlements but mainly because the natives can make a living with less exertion by occasional service in the villages. In other words, even here in Arctic Alaska the transmutation of a rural to an urban population is in progress, with all the undesirable consequences of such a change. Many of the former customs and practices of the natives have disappeared with the coming of the whites, but their old friendliness, intelligence, proficiency in their own occupations, and interest in the doings of others still make these people not only interesting subjects of study but also good companions.

The Brooks Range

In broad terms the country may be divided into three rather distinct topographic units, which in order from south to north are the mountains, the plateaus, and the coastal plain.

The mountains trend in general east-west and are part of the great mountain region that extends eastward to the international boundary. To this major highland area the name Brooks Range has recently been given, in honor of the late Dr. Alfred H. Brooks, the distinguished explorer, geologist, and geographer who did more than any other man to make Alaska understood and appreciated. The Brooks Range is made up of groups of smaller mountain masses and will doubtless be further subdivided as the surveys of the region are completed. It is at least 150 miles wide; its higher peaks rise to elevations of 8000 feet or more, and its crest averages 5000 to 6000 feet above the sea. These mountains are formed of folded and deformed rocks of Paleozoic age which are here and there intruded by granitic masses. Veins bearing metallic minerals occur at places in the mountains, and some productive gold placers have been developed near the southern margin of the range, where the topography is less rugged

and more accessible than in the higher central parts. All the peaks can be climbed, although many of their slopes are precipitous and cannot be scaled by direct routes. At intervals across the range there are passes that can be traversed by loaded dog teams or by packers. The elevation of the pass traversed by Schrader in 1901 is about 2500 feet; that traversed by the parties of Smith and Mertie in 1924 is about 3900 feet; that traversed by Smith in 1911 is a little over 3800 feet, although near this place another

FIG. 1—Sketch map of Alaska showing position of Naval Petroleum Reserve No. 4 and the area covered in more detail by Fig. 2. Map furnished by U. S. Geological Survey. The scale is approximately 1: 25,000,000. Juneau is in latitude 57° 30′ N., longitude 134° 30′ W.

pass at an elevation of about 3000 feet was seen; and that traversed by Foran in 1924 is 3200 feet. In general the drainage of the Brooks Range in northwestern Alaska is northward or southward, being apparently consequent on the general constructional slopes of the mountain mass.

It is perhaps surprising to learn that in these mountains east of the 150th meridian only two or three glaciers, and these not more than a mile or two long, have been seen by the Survey's parties. The absence of glaciers is probably due to the very small precipitation. In the past, however, these mountains were the site of glaciers which formed near the higher parts of the range and flowed outward down the valleys, eroding them and giving them typical glaciated aspects. Apparently these old glaciers did not extend far beyond the front of the mountains on the north and nowhere reached the main Colville River. Moraines formed by these old glaciers have been trenched across by the larger side streams, the courses of which are thus obstructed for navigation even by canoes.

FIG. 2—Map of Northwestern Alaska redrawn from the preliminary sketch "Northwestern Portion of Arctic Alaska," by the U. S. Geological Survey. Scale 1: 3,800,000.

The Plateaus North of the Mountains

At their northern limit the mountains end abruptly and are succeeded by gently rolling plateaus. Near the mountains the surface of the plateaus stands at an elevation of about 2000 feet, but farther north it becomes gradually lower until, 50 or 75 miles south of the coast it is only a few hundred feet high. The plateau region, as the term is here used, embraces a tract about 100 miles wide, formed of rather gently folded rocks, mainly sandstone and shale containing numerous coal beds. On the whole the rocks have a relatively low resistance to erosion, and their trend has in large part determined the direction of the streams. Erosion has not proceeded far enough to destroy much of the upland surface or to open out wide-floored valleys. The streams flow in fairly narrow valleys cut rather steeply below the uplands, and the larger streams have rocky walls along parts of their courses. Many of the small streams flow in shallow trenches cut only a few feet below the old surface. The larger part of the plateau region is drained eastward by the Colville and its tributaries, but the northern part drains northward to the Arctic Ocean by way of Ikpikpuk, Meade, and Kuk Rivers, and the western part by the Utukok and other streams that flow into the Arctic Ocean. The uplands of the plateau stretch away with a monotonous aspect, so undiversified that usually even the courses of the major drainage lines cannot be recognized from a distance of more than a few miles.

Coastal Plain and Coast Line

The coastal plain is a tract a few miles wide in the western part of the region that broadens toward the east until it is nearly 75 miles wide south of Barrow. Its surface is composed mainly of deposits of sand, mud, and gravel, unconsolidated except for ice, which fills the interstices and binds the materials firmly together. These deposits probably overlie rocks similar to those that are exposed farther south in the plateau region. The surface of this province as a whole is extremely monotonous. Sand dunes a few feet high near the courses of the larger streams are the only points that rise above the general level of the smooth plain. The larger rivers cross the coastal plain in channels that during low water have steep sandy or silty banks rising a few feet above the water, but during the period of high water in the spring these banks are submerged, as is also much of the adjacent country. The streams have tortuous courses through the coastal plain, and the northern parts of many of them appear to have been rather recently depressed below the sea, giving rise to estuaries. Near the coast many of the streams split into several channels or distributaries. By choosing the proper channel in such cases the traveler may avoid journeys along the exposed coast. For instance, it is reported that one may go from Peard Bay to Harrison Bay, an air-line distance of 150 miles, by an inside route with only two short portages, without having to traverse the Arctic Ocean.

FIG. 3

FIG. 4

FIG. 3—View up the Unakserak, a tributary of the Alatna, which affords the route that was followed in crossing the Brooks Range.

FIG. 4—Northern extreme of timber on the Unakserak, with the crest of the Brooks Range in the background.

FIG. 5

FIG. 6

FIG. 5—View from the summit of Survey Pass across the Brooks Range in April.
FIG. 6—View southward into Survey Pass, flanked by mountains about 6000 feet high, from the Colville side of the divide.

The coast in the eastern part of the region is indented by numerous bays, in most of which the water is very shallow, the land merging into the sea so gradually that at a distance of even a few miles the shore line cannot be distinguished. During the journey by canoe along the coast of the Arctic Ocean the west side of Smith Bay was entirely unrecognizable from the head of the bay, and even the shore not a mile away was inferred only from the presence of stranded logs along the beach, which apparently floated several feet up in the air. This effect was due to mirage, which is very common near the coast and which, together with the small relief of the country, makes the estimation of distances or the correct recognition of objects extremely difficult. One who has experienced these difficulties is willing to admit the truth of the story told by Stefansson, who relates that after he had stalked for an hour what he supposed to be a grizzly bear he found that the animal was only a marmot, which was sitting but a score of yards away from the point where his hunt began.

West of Point Barrow the coast is fronted by sand reefs, and trimmed by waves and currents so that it has long sweeping curves. Here and there where the ocean beats directly on the mainland it has cut cliffs, some of which are as much as 50 feet high. Where the mainland is protected by offshore sand reefs its coast line is more or less irregular, and the streams have built deltas into the lagoons that lie behind the reefs.

Climate and the Weather of 1924

It has been frequently pointed out that even northern Alaska is by no means a land of perpetual snow and ice. We are told that records made in New England or Montana show temperatures lower than any experienced during the 14 years for which records have been kept at Barrow, the northernmost part of northwestern Alaska. However, not to be misled by this statement, the reader should realize that it refers only to short-period minima, and although these are of interest they have less effect on life in a region than the average or mean temperature. The January temperatures in northern Alaska are about the same as those in the country adjacent to Hudson Bay, the July temperatures are about those of northern Newfoundland or Labrador. The mean temperature for the whole year at Barrow is approximately 10° F. As might be expected, however, the record at Barrow does not represent the temperature of the region as a whole. The extremes of temperature become greater southward from Barrow as the altitude is higher and the country is more remote from the ameliorating effect of the ocean. At Allakaket, about 350 miles south of Barrow, for instance, a much greater range of temperature has been recorded, the lowest temperature at these two places being, respectively, −54° and −70° and the highest 75° and 90°. The mean annual temperature at Allakaket is 18°.

Northwestern Alaska has an extremely arid climate, if judged by the records of precipitation, for according to these the average annual precipi-

FIG. 7

FIG. 8

FIG. 7—Winter headquarters in willow thicket in the mountains near the head of boating water on Killik River, a northward-flowing tributary of Colville River. Photograph taken April 12, 1924.

FIG. 8—View from a point near the same headquarters, showing contrast between winter and spring aspects of the region. Photograph taken May 23, 1924.

tation at Barrow is only 5.56 inches and at Allakaket 12.24 inches. The casual traveler, however, will probably not be sensible of this aridity, for in the summer, the season in which he is most likely to be abroad, the precipitation is heaviest, and if he is near the coast he will be enveloped and hindered many days by damp fogs and occasional showers that give him the notion that he has been constantly wet. Furthermore, the large amount of water which he sees everywhere on the surface and the marshes on most of the uplands will leave a lasting impression of a moist, swampy region, though the swampiness is due to the fact that the soil is frozen, so that the water is not carried away underground. Neither the vegetation that the traveler sees on every side nor the character of the erosion resembles that typical of the arid regions with which he is likely to be familiar.

The snowfall of the region is usually small, but the boisterous winds sweep it away from some places and pile it in great drifts in others, so that trails which are not used constantly soon become obliterated. On many of our trips tracks only a few hours old were entirely unrecognizable. Snow may fall in any month of the year, and, probably because we were least well prepared for them, the snowstorms in the summer were far more disagreeable than those in the winter.

The most significant events of the year are the closing of the streams and ocean in the fall and their opening in the spring, and all local chronology is dated from the "freeze-up" or the "break-up." The open season on the coast in the vicinity of Barrow—that is the period during which ships can traverse the Arctic Ocean—is practically limited to the month of August. It is true that in some years ships can reach this place about July 20 and that vessels have remained as late as the second week in September, but this extra season is made possible only by exceptionally favorable conditions or by taking grave hazards. In 1924 the Coast Guard steamer *Bear* was so badly crippled by ice in July that she was forced to turn southward for repairs without reaching Barrow; the trading and supply vessel *Arctic*, which reached Barrow the first week in August, was crushed by ice and became a total wreck a few miles south of the town on August 9; the Hudson's Bay Company's ship *Lady Kindersley* was caught in ice early in August and was abandoned as a total loss shortly before the end of that month; and the *Lettie C*, southbound from points east of Barrow, was caught in the ice and finally wrecked near Wainwright in September.

The "break-up" of the ice-bound streams proceeds progressively from their headwaters toward their mouths, so that there is considerable difference in the time of the "break-up" in different parts of the same valley. In 1924 the first small stream near our winter camp in the mountains broke up May 19; water was flowing by this camp in the main stream on May 28, and we were using canoes on May 31.

The prevailing winds of northwestern Alaska are east or northeast. In the mountains the winds tend to follow the larger valleys, so that their direction is much more variable and inconstant than over the regions of low

topographic relief. Actual as well as sensible temperatures are very materially affected by the occurrence or the absence of wind. On a quiet day a temperature of as much as 30° below zero is not at all unpleasant if one is suitably clothed; but on a windy day a temperature of zero, other conditions being the same, is much less bearable. People familiar with the region during the winter state that when strong winds begin, the only thing one

FIG. 9—Typical camp on the divide between the Colville and Ikpikpuk basins. Note the absence of brush: the canoes are used as side stakes for tying the tent. Tent poles and pegs were carried by the Expedition owing to the absence of wood in the region.

caught out in such weather can do is to "hole-up" in a sleeping bag or with such protection as may be had until the blow is over.

By the time our parties reached the region, early in March, we had a twelve-hour day without the need of artificial light; by late April it was sufficiently light to enable us to travel all night and see the trail rather distinctly, and from the third week of May until the last week in July in latitude 69° the sun was above the horizon all the time. Even in the later part of August it was so light that we could plainly see landmarks throughout the night.

Trees and Plants

Practically all of northwestern Alaska lies north of the limits of trees, as we of more southern latitudes use the term. The "farthest north" for spruce on the Unakserak is ten miles south of the summit of Survey Pass;

on the Alatna, about four miles below the portage leading from that stream to the Noatak; and the farthest north and east on the Noatak is near the mouth of the canyon above Kugururuk River. Even in these valleys spruce is restricted to the valley floors or the lower slopes, and throughout the greater part of the region the only wood available is furnished by willows. Even the willows are confined to a narrow fringe along the streams; the mountain slopes and the uplands of the plateaus and plains are entirely bare of trees or bushes. Doubtless temperature, soil, and other elements influence or determine the distribution of the trees and bushes, but wind is probably also potent in controlling their distribution. Throughout the valleys of the mountain and plateau area traversed willows are sufficiently abundant to furnish camp fuel if the camp site is properly selected. In the coastal plain province even bushes are far apart and too small to use as fuel. Fortunately, in this region we found that driftwood which had been brought down by the rivers from the willow thickets farther upstream or by ocean currents from the spruce and cottonwood forests of the Mackenzie or the Yukon was sufficiently abundant to supply all camp needs if assiduously gathered from the bars and banks as we traveled.

The plateau country back of the fringe of willows or alders that line the streams is generally covered with moss or grass and here and there with numerous small, prostrate woody shrubs. The grasses and sedges are mostly coarse and do not appear to be suitable for horse feed, though at a few places, especially along the borders of the streams between the water and the fringe of willows, patches of grass similar to redtop were noted. The whole vegetation forms a spongy mat, difficult and tiresome to traverse except along the better-drained crests of the ridges, where it becomes thin and particles of the disintegrated underlying bedrock are abundant. In the larger part of the Colville basin the willows were not in full leaf until well into July, and killing frosts occurred late in August, so that the growing season is very short. In the mountains much of the surface away from the streams is formed of bare ledges or talus, and, except for the abundant lichens that grow on the rocks, vegetation is scanty. It is interesting to note, however, that even on the steep slopes of many of the higher hills wild sheep browsed on this scanty vegetation and apparently found it sufficient.

Berries were seen at a number of places in the plateau region, but they were not plentiful enough to contribute materially to our food supply. Salmonberries and cranberries were the most abundant. Although blueberry bushes were common, the season of 1924 was apparently too backward to ripen the berries. The beauty of many of the scenes was enhanced by a great profusion of flowers. The snow was hardly off the ground before the hardy plants were in bloom and the benches near the streams were dotted with white, purple, yellow, and pink flowers.

Animals and Wild Life

In a frontier region the number and the distribution of animals are matters of vital concern, for animals may contribute largely to the food supply and may furnish clothing as well as material for covering boats and houses or for constructing implements and equipment. Throughout most of northwestern Alaska wild animals are so numerous that they supply many of the needs of the present population, though in the vicinity of the settlements they have been killed off, so that they must be hunted in more remote regions.

In the mountains the most abundant large animals are mountain sheep, whose meat forms a delicious food and whose hides are said to make the most durable clothing and sleeping bags. Before the advent of the whites their horns were extensively used in the manufacture of ladles and similar culinary articles. These animals live on the higher peaks in the less accessible parts of the region and are now little hunted, so that they are often seen in flocks of 10 to 30. North of the mountains, in the plateaus, the commonest large animals are caribou. No large herds of these animals were seen, but almost everywhere in the plateau region search for them discovered groups of 2 to 15. Caribou are valuable for their meat, hides, sinew, and antlers. Formerly these animals were extensively hunted, but nowadays the herds of reindeer that are grazed near the coast furnish a much more convenient source of supply, so that the caribou in the remote parts of the region have been less molested.

Foxes, notably the white fox, which is found near the coast and on the sea ice, probably furnish the most valuable part of the fur that is shipped out of the country. Red, cross, and black foxes were seen in almost all parts of the region from the mountains to the coast. Bear are said to be rather common in the southern part of the Brooks Range, but only a few signs of these animals were seen north of the mountains, and probably they are not numerous in any of the inland country, though polar bear are frequently obtained near the coast and on the ice pack offshore. Rabbits are numerous in the mountains and during a good season can probably be relied on as a source of food.

Birds are numerous. The birds most used for food are ducks and geese near the coast and ptarmigan in the plateaus and mountains, though swans and cranes are also hunted as food. The first northward-bound geese passed over our camp in the mountains on May 7, and for the next few weeks flocks, many of them including several score, passed at frequent intervals. On reaching the Arctic Ocean, late in August, we saw enormous flocks of ducks—in fact, in the stretch from the head of Smith Bay to Tangent Point, as we paddled along in the evening, we saw the water in places literally black with thousands of them. Not only are many of the birds of the region valuable as food, but the skins of some of them are used by the natives for clothing or for the decoration of small articles. Other birds that were commonly seen but that are not hunted, except under stress of

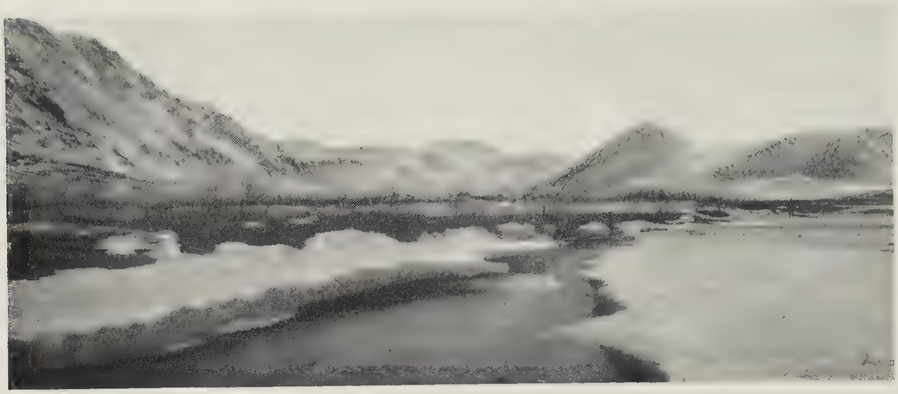

FIG. 10

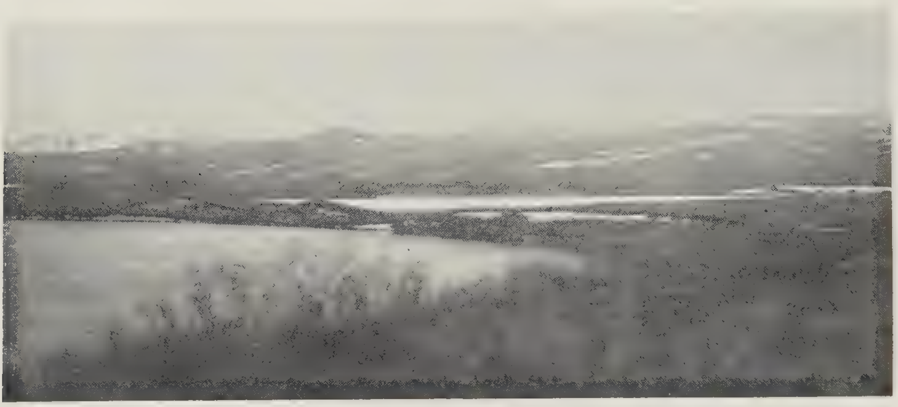

FIG. 11

FIG. 12

FIG. 10—First open water a few miles below winter headquarters on Killik River. Hundreds of grayling lived in this pool. Photograph taken May 26, 1924.

FIG. 11—The Killik River crossing the morainic belt in the plateau province. The river flows in a channel at the base of the first snowbanks beyond the near lake.

FIG. 12—Characteristic topography of the plateau province, with channels of Killik River in foreground, which have been cut through overflow ice formed during the preceding winter. Photograph taken June 9, 1924.

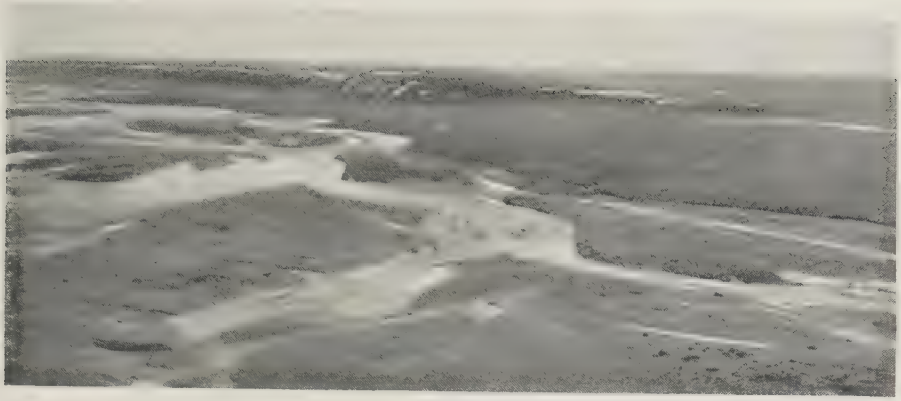

Fig. 13

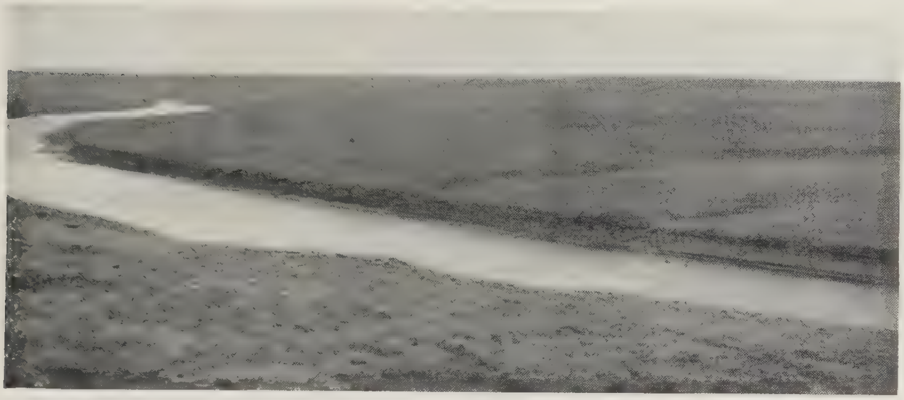

Fig. 14

Fig. 15

Fig. 13—View southward up Killik River from point above its junction with the Colville, showing the general aspects of the plateau region and the larger streams that flow across it. Photograph taken June 18, 1924.

Fig. 14—View westward in the plateau region, looking toward the head of one of the western tributaries of the Colville.

Fig. 15—Small northward-flowing tributary of the Ikpikpuk. The upland in the background is the nearly smooth plateau that forms the divide between this stream and the Colville.

hunger, are robins, camp robbers, eagles, hawks, owls, snipe, loons, and gulls.

No account of the wild life of northwestern Alaska would be complete if it omitted mention of the insects. From July 15 to August 10 mosquitoes, gnats, and related small stinging insects made life in the open almost unendurable. Most of the members of the party wore veils continuously when out of doors and built smudges whenever they were not in motion. Flies were common around our winter camp many days before the streams broke and were seen in Barrow at the beginning of September. Insect parasites were found on many of the animals killed. More agreeable members of the great class of insects were the bumblebees and butterflies, which during the summer were fairly common throughout most of the open lowlands of the plateau province.

Resources

In the foregoing description an attempt has been made to portray northwestern Alaska as it is. Now comes the larger questions—What will this region become? What are its resources and its potentialities? Prophecy is a hazardous undertaking under any conditions, and it is especially hazardous for a region such as this, where many of the essential data are not available. It is certain, however, that the region contains large reserves of natural products and that it is not so inhospitable as to preclude further settlement.

Unquestionably petroleum occurs in the region, as is proved by the seeps that have been examined by the Geological Survey at Cape Simpson. How widely distributed are the oil sands, how much oil do the productive beds contain, and what are the proper methods of winning the oil are technical questions that cannot yet be answered, though some of the problems involved are in course of solution. It seems certain that when the struggle for oil reaches a more acute stage, owing to the depletion of the more accessible oil fields, northwestern Alaska may be listed among the places in which oil will be sought. Another of the great but still undeveloped natural resources of northwestern Alaska is coal. More than a dozen beds of subbituminous and bituminous coal that range from 4 to 20 feet in thickness are known, and coal-bearing rocks have been found through a belt of country more than 100 miles wide and 300 miles long. Probably these deposits will be used first in local development within the region, where, because of the absence of other fuel, they will have especial value. There is little reason to doubt, however, that as development of the country proceeds some of this coal may be sent to more remote markets, for many of the beds crop out near the coast, where the coal could be lightered to seagoing vessels. Metallic minerals may be sought with some assurance of success near the southern limits of the mountains, where the older rocks occur, and even in the geologically later rocks that form the central and northern

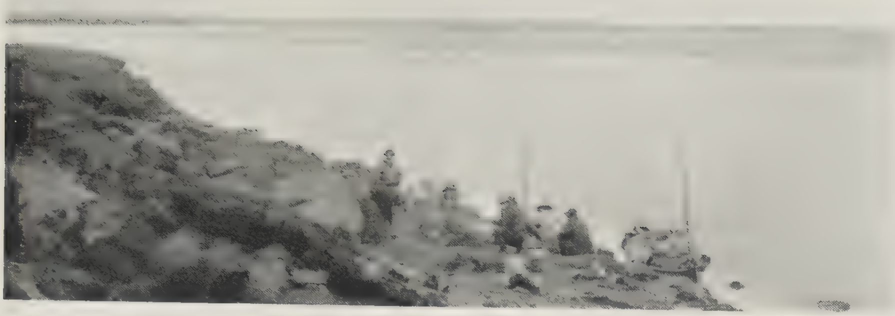

FIG. 16

FIG. 17

FIG. 18

FIG. 16—Ikpikpuk River in its coastal part, about 40 miles in an air line from its mouth.

FIG. 17—Ice packed so solidly against coast at Barrow, on August 22, that no stretch of water large enough to float a canoe was visible as far as the eye could see.

FIG. 18—Ice pack at Barrow beginning to open up through the influence of strong easterly winds. The trading post and native settlement are seen in the distance across the lake. Photograph taken August 31, 1924.

parts of the Brooks Range, in those places where igneous intrusions have brought ore-bearing solutions from deep-seated sources to the zone that is now exposed by erosion. Although the first output from this source will be obtained from deposits that are easily mined, such as gold placers, the physical history of the mountains suggests that such deposits are irregularly distributed and that a permanent metallic mining industry must depend upon the development of lodes.

The region does not appear to hold promise for agricultural development. To one who has seen the tender solicitude displayed by some of the people living near the coast in raising a few leaves of lettuce or a few radishes, it is obvious that cultivation of crops that would be likely to contribute in appreciable quantities directly to the food supply is improbable. The vegetation of the region can, however, make an indirect contribution thereto, for there are thousands of square miles of the plains and plateau region that are in all essential respects similar to regions in which reindeer are now being successfully pastured. Although the present scanty population and the great distance from market make grazing in this region now a venture that should be undertaken only with full knowledge of its speculative character, nevertheless there is justification for the forecast that when the other resources of this region are more developed and when the agricultural possibilities of more favored regions are more fully utilized for crops, grazing in northwestern Alaska may become an important business.

As the development of a wild region progresses, game is driven out or exterminated. A long time, however, will elapse before this country reaches that stage, and until then it can furnish many more furs than it does now. Hunting and trapping are therefore among the enterprises likely to increase first as the region is developed, and, as they always have been, they will in themselves be a cause of its increased development. The waters off this coast have furnished many animals and fish that were profitably caught by the whites when the Arctic Ocean was uncharted and the adjacent country was inhabited only by Eskimos. Their crop has not been exhausted and may long be counted on as one of the great resources of the region. All these resources interact, so that the successful development of one inevitably stimulates that of the others. He would be a pessimist indeed who did not regard the resources of northwestern Alaska as valuable future assets of our country.

THE EARTH'S EVOLUTION*

By Sir Napier Shaw

The Argument

Here we must bring this study of the earth's evolution to a close. Its fundamental principle has been that the present, if rightly understood, affords a full key to the past. . . . We have endeavored to discover new truth concerning the physical environment that has molded the evolution of all life.

In these words Professors Huntington and Visher sum up their achievements in the companion volumes "Earth and Sun" and "Climatic Changes." The study is so extensive, both in its range and its claim on the reader, that it will be best first to trace the line of the argument so far as it can be formulated by a retentive reader.

The predominant influence of physical environment is with the atmosphere, the changes in which we call weather. Those changes may be summarized or generalized as climate, which itself has been subject to change throughout the geological era of the evolution of life. The primary control of weather and consequently of climate lies in the play between the influence of the sun, which operates by radiation, mainly perhaps thermally but also, to some extent, electrically, and the counter-radiation of the earth, which is also mainly thermal but still must have its electrical or electronic share; both are dependent upon temperature. The primary cause of changes in climate of a temporary nature, such as have been disclosed by Douglass' investigation of the rings of the *Sequoia* and other evidences, during the historic period, lies in the variations in the sun's radiation, thermal and electrical; the activity of the sun is greater at times of maxima of sun spots and less at times of minima. If we suppose the variations in solar activity exaggerated from time to time, at intervals of tens or hundreds of thousands of years instead of the day, the year, or group of few years of the historic period, greater changes of climate would naturally be produced, such as those represented within historic times by the remarkable climatic stress of the fourteenth century, in prehistoric times by the last ice age, and in geological times by the ice ages of the geologic past with the intervening periods of mild climate, much warmer than that of the present day, for which millions of years are required. We can associate the well-known period of the variation of sun spots of about eleven years with the periodic changes in the positions of the planets, particularly of Jupiter and Saturn. We can, therefore, associate the minor changes of the historical period with the approaches of those heavenly bodies to the sun, yet

* Ellsworth Huntington: Earth and Sun. Yale University Press, 1923.
Ellsworth Huntington and S. S. Visher: Climatic Changes: Their Nature and Causes. Yale University Press, 1922.

we can find no explanation of the increased activity of the sun in the increased gravitational force of those bodies nor yet in the tidal effect produced by the rotation of the sun under their increased gravitational force.

> The agency through which the planets influence the solar atmosphere is not yet clear. The suggested agencies are the direct pull of gravitation, the tidal effect of the planets, and an electro-magnetic effect. In *Earth and Sun* the conclusion is reached that the first two are out of the question, a conclusion in which E. W. Brown acquiesces. Unless some unknown cause is appealed to, this leaves an electro-magnetic hypothesis as the only one which has a reasonable foundation. Schuster inclines to this view.[1]

Proceeding from a quotation from O. W. Richardson[2] we next arrive at the conception of an electromagnetic hypothesis as explaining the variation of solar activity with the natural extension to assume that, according to its temperature, every body in the universe must be thermionic and act electromagnetically upon every other body with an intensity that depends on the area of the influencing body and inversely as some power of the distance. In order to account for the major changes in the sun's activity which have caused the great fluctuations in climate within geologic times, the planetary influences are too small; but the power of the stars may be invoked; we have only to look out in the universe for suitable visiting stars. With Professor Schlesinger's assistance we find that there are twenty-six which might do something[3]: four of them, Sirius, Altair, Alpha Centauri, and Procyon are the chief. From their positions, assuming their electrical influence to be proportional to their known luminosity, we can construct a curve of disturbance of the past and future extending 70,000 years either way, which gives a fair estimate of the date of the last glacial epoch and insures us against another for 70,000 years.[4]

We are not to forget that the distribution of land and water is a recognized element of terrestrial climate; but even the changes in that distribution may be regarded as secondary effects of atmospheric changes, because even earthquakes, which represent the readjustment of land areas under stress of contraction or increased angular velocity, are found on inquiry to be dependent upon weather, being most frequent in winter when storms are also most frequent.[5]

To put the whole conclusion in a sentence, evolution, both physical and biological, is a function of the exchange of electromagnetic radiation or influence among the heavenly bodies, sun, planets, and stars, and is controlled by the relative positions of those bodies. We begin again with a new astrology freed from the assumptions which have degraded that science since the time of the Babylonian astronomers and based upon a rational extension of modern electromagnetic theory.

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1 Climatic Changes, p. 244.
2 *Ibid.*, p. 256.
3 *Ibid.*, pp. 276–277.
4 *Ibid.*, p. 278.
5 *Ibid.*, Ch. 16.

The Sciences Invoked

The steps to this conclusion, as stupendous apparently as the law of gravitation itself, are the various chapters of the two books. "Earth and Sun" gives the evidence for the use of sun spots as an indication of solar activity, explores the possibility of the influence of electrical radiation upon climate, and deals with the causation of sun spots by planetary influence. In "Climatic Changes" the uniformity and variability of climate in geological times are examined, the historical changes of climate are discussed, the problems of glacial and interglacial periods are exposed. The possible causes of change in the sun's atmosphere and the earth's atmosphere are considered, and finally we are initiated into the general stellar-solar hypothesis of climatic change. By way of appendix the geological changes in the earth's crust are dealt with in the manner already described.

These are such magnificent sweeps of the magic wand of science that it is not at all clear with which of the sciences ancillary to geography the subject should be specially associated. The problem is primarily geological; it is the change of climate in geologic time for which an explanation is sought; the "works" of the machine by which the problem is handled are made up of history, solar physics, electricity in its most modern form, stellar physics, and astronomy, as well as biology. But the cutting edge of the machine is in fact meteorology, because the real object of the research, climate, or generalized weather, is the result of atmospheric changes, and all the electrical, planetary, and stellar influences must be ultimately expressed in terms of meteorological elements—temperature, rainfall, "storminess" or pressure gradient. Biology comes in as a criterion, after a preliminary discussion of the evidence of comparative uniformity of climate throughout the ages of geologic time, by the continuity of organic life which could not tolerate any very wide departure from the physical conditions to which it has become accustomed. And here, parenthetically, we may remark that, of all the conceptions with which they deal, life appeals to the authors as the eternally immutable. Environment may destroy lives, but it cannot really alter life. The sun may vary, the mountains disappear in the ocean, and all things apparently be in course of change; but, in spite of the millions of years that have elapsed, coal in the Arctic and "warmth-loving" creatures in the polar regions are accepted as undeniable evidence of change of *climate*, not of change in *life*.

> The stars shall fade away, the sun himself
> Grow dim with age, and nature sink in years,
> But thou shalt flourish in immortal youth
> Unhurt amidst the war of elements,
> The wreck of matter and the crash of worlds.

So vast is the range of the sciences invoked in the discussion of the earth's evolution that few readers can be in a position to undertake a critical appreciation of the whole. Students of atmospheric electricity may wonder

whether the potential gradient at the surface, which has been chosen as the criterion of electrical variation under solar influence, is really the proper element for that kind of inquiry, considering how liable it is to influences of the most mundane character—dust and snow and the things which are of the earth earthy. They may also wonder whether any reasoning based upon area as distinguished from mass is really effective in the case of the heavenly bodies, which may consist of tenuous atmospheres. A recent number of *Nature*, for example, gives the pressure of the sun's atmosphere at the level of the photosphere as only 100 millibars. And altogether the electromagnetic influences which are presumed to be operative over thousands of millions of miles are only sketchy. Still, we all know that electricity is a very potent influence, and we must be content to have it treated in a sketchy manner until we know more about it. But, frankly, we do not like the reasoning that since only three suggestions are offered and two of them have been proved to be unworkable the third must be accepted. Inductive sciences have never found that to be a very satisfactory mode of procedure. Its ultimate foundation is ignorance, and science is knowledge.

Of those things the experts of the several sciences must be left to give their opinion if they so desire. The cutting edge of the machine is, as we have said, meteorological. Yet internal evidence goes to show that the mental attitude of the authors is not exactly that which is common among meteorologists. We are accustomed to a curious meticulous accuracy in small details that is offended by such trifling defects as misprinting "de Quervain" as "Guervain" and other similar slips with the names of authors referred to in the text and notes. Further, in the discussion of electrical potential gradient, data are quoted for Kew Observatory which are not known to exist at the Observatory itself. And the sensitiveness about these trifling inaccuracies is only one aspect of a cautiousness which is habitual with meteorologists because they are constrained not only as regards references and data but also as regards inferences and conclusions. They have not the spacious liberty of the geologist or the astronomer or the biologist. Any scientific inference which a meteorologist draws from the facts of the present or the past is liable to be confronted with actual facts within a few hours or days or years; and he feels uncomfortable and nebulous about conclusions expressed in "par-secs" or "light years," or even in the millions of years of geologic time, which are out of range of the means of verification customary in meteorology. No meteorologist, for example, could pen the following sentences: "Each of these secondary hypotheses is in its way important. Yet any or all may prove untrue without altering our main conclusions." He could not bring himself to say anything was important which did not matter. And both books abound in remarks of a somewhat similar character. One is repeatedly reminded of the politician's address to his constituents, "These are my views, but if you do not like them they can be altered." "The conditions which any satisfactory climatic hypothesis must satisfy are briefly as follows:" due weight must be

given to this, attention paid to that, etc. For a meteorologist the only criterion for a satisfactory climatic hypothesis is agreement with the facts, nothing more and nothing less. It is natural for him to feel that a clear statement of the salient facts should precede an effort to compile a theory.

This apparent detachment from the care which rides at the back of the ordinary mortal in his efforts to make out the riddle of the physical universe leads to an Olympian style and arrangement. We are invited to begin the study of climatic changes, not with the humble question of the evidences of change of climate beginning with the day and carried on through the year and periods of years to geological eons, but with a Jovian summary of the types of climatic sequence in progress: (1) cosmic uniformity, (2) secular progression, (3) geologic oscillations, (4) glacial fluctuations, (5) orbital precessions, (6) historical pulsations, (7) Brückner periods, (8) sun-spot cycles, (9) seasonal alternations, (10) pleionian migrations, (11) cyclonic vacillations, (12) daily vibrations; and for each in turn we are invited to adopt a hypothesis which may become a theory. A meteorologist of ordinary humility would have gone the other way of the ladder, would have begun at the bottom with changes of which he had indisputable evidence and would have gradually extended his range of vision; he would have looked forward to that table of climatic changes as a triumphant final conclusion of his exposition of the variability of climate and would have led up to it in his last chapter instead of putting it in the first paragraph.

Still these are mere scientific idiosyncrasies; the evidence is the evidence all the same.

The Steps of the Edifice

If we examine the several steps which lead to the final conclusion we may find a good deal of opportunity for discussion. The reasoning is often of an inconclusive character, and one develops a bad habit of challenging almost every sentence—a habit that makes books very hard to read.

Take, for example, a theme of which a good deal is made, though it is not of very vital importance so long as the facts are sound: "A hot sun and a cool earth."[6] That is an apparent paradox taken over by the authors with some emendation from Professor W. J. Humphreys, who has displayed his usual ingenuity in expounding it. But it is a paradox about which any ordinary meteorologist must feel convinced that there is a snag somewhere. Imagine the consequences of it when it is paraphrased as "the greater the amount of solar radiation the cooler the earth." For the separate hemispheres it conflicts with our experience of summer and winter; and if, as we all believe, the earth would be colder if the sun were extinguished altogether, it implies that somewhere between zero and normal radiation there is an optimum value which would give maximum warmth on the earth, "a thing imagination boggles at." The betting is a thousand

[6] Earth and Sun, Ch. 4.

to one on something logarithmic against a conic-sectional representation. But in enunciating and discussing this paradox the authors do not state clearly the origin of the data from which the conclusion is derived. Let us put an alternative in syllogistic form: (1) The mean temperature of land areas in the tropics is *lowered* by the presence of cloud. One could easily support that statement by statistics of British India. (2) *Cloud over the land areas* is derived from the evaporation of water from seas and lakes. A vague statement but, in our authors' phraseology, "not unreasonable." (3) *Evaporation from seas and lakes* is increased by the *increase* of temperature of the water. Almost undeniable. Hence *hot seas* mean *cool land areas;* and, if the estimate of the temperature of the earth is taken from land observations alone, a false conclusion may easily be arrived at.

Or take another and more vital example. The authors suggest in "Climatic Changes"[7] that *diminished* storminess over the Atlantic Ocean means *increased* westerly winds; they give diagrams to enforce and illustrate the conclusion. That is certainly a surprise for ordinary meteorologists. Not only would they think that the westerly winds, being an essential part of the general circulation of the atmosphere, and the cyclonic disturbances, being another essential part of the same circulation, would increase together, if not *pari passu* at any rate in association one with the other; but, further, they generally regard the superposition of a cyclonic depression upon a normal circulation as increasing the westerlies on its southern side by quite as much as it reduces westerlies or supplies easterlies on its northern side; that feature is apparent in untold numbers of weather charts of the Atlantic Ocean. If so, increased storminess means increased westerlies in the area under consideration.

We say little about the measures of storminess and pressure gradients upon which is based much of the meteorological work of the books, only that it is rather a reversal of the adage *ex pede Herculem* into *ex Hercule pedem*; the path of nature is judged by an examination of one of her creations—the number of cyclonic centers in the United States in the one case, and a curious estimate of the state of pressure over the North Atlantic in the other. For years we have been on the lookout for some feature of the atmospheric circulation that could be regarded as a trustworthy index of the whole activity. The trade winds strike one as being the most promising, but there are many others; and we hesitate to accept the rather arbitrary definitions of storminess or gradient which the authors have used without some inquiry into their relation to the other features of the general circulation. Meanwhile the authors may be glad to know that the Dekadenbericht of the Deutsche Seewarte is not the only or even the most complete source of information about meteorological conditions day by day over the Atlantic; the charts published for many years by the Danish Office and the Seewarte conjointly, in continuation of Hoffmeyer's charts, are much more complete and would have been more effective for their purpose.

[7] Climatic Changes, Ch. 10.

The Method of Correlation

But we have a remark or two to make about the applications of the method of correlation which are to be found in the various chapters of the books under review but not by any means, be it said, in these books alone. The dictum of the statisticians that a correlation coefficient has real significance if it is three or four times its probable error is responsible for much expenditure of time on objects that are not really worth it. In the cases in question we have nothing to complain of in the application of the method to the relation between rainfall and the growth of trees, for which the correlation coefficients are of the order of 0.4 to 0.6. They make good a claim, "bar accidents," to a quarter of the tree growth, but the correlations between sun spots and meteorological data,[8] laborious as the work of compiling them must have been, are ludicrous, especially in their monthly irregularity, as expressing a reasoned relation in view of the arbitrary character of the data both solar and terrestrial. Barometric pressure and rainfall would not be regarded in these days as having more than a very vague relationship for Kew; but its correlation coefficient is ten times that of sun spots. We are told by our statistical friends that the square of the correlation coefficient indicates the fraction of the one quantity that is controlled by the other. If so, it is not really worth while to pursue correlation coefficients less than 0.3, which allows only ten per cent of reciprocal control, except in those cases where the quantities are so well-defined and the data are so numerous that the laws of probability based upon great numbers of observations can be implicitly relied upon. We may have complete confidence in a correlation coefficient between the phase of the moon and the atmospheric pressure at some point on the earth's surface because both measurements are precise and almost unlimited in number; but with arbitrary definitions of meterological features and such a vague element as sun spots, labor is only justified by coefficients of large magnitude.

Perhaps, however, the limit of the method of correlation is reached where[9] the relation between sun spots and earthquakes in the same month is worked out as + 0.042, or 1.5 times the probable error; sun spots of a given month and earthquakes of that month and the next as + 0.084, or 3.1 times the probable error; sun spots of three consecutive months and earthquakes of three consecutive months allowing a lag of a month as + 0.112, or 4.1 times the probable error. The coefficients are so small that the conclusion to be drawn is that other causes than sun spots account for at least 79 earthquakes out of 80.

The Conclusions

All these considerations leave us doubtful about the conclusions. The fact is that one of the most noticeable habits of the authors is to put for-

[8] Earth and Sun, Table 18, p. 129, and Table 19, pp. 131–132.

[9] Climatic Changes, p. 291.

ward various hypotheses upon such facts as happen to be available and to disarm criticism by explaining that the hypothesis may be wrong after all but that the possible consequences of its being right are so important that they are impelled to offer the hypothesis, all unverified as it is, as an invitation to further study. This makes the work extremely difficult to read and still more difficult to describe. One is reminded of Mr. Puff's explanation of his histrionic reason for staging the loves of Tilburina and Whiskerandos, "things just so strange that though they never did they might happen." So with many of these relations meteorological, geological, astronomical, and biological, no one can agree that they are proved, yet nobody can say that they are untrue. Almost everything has to be left suggested but unsettled, for future researches to verify or contradict. As one passes page after page one becomes moved to remind the authors that the sciences of physical astronomy, or stellar physics, geology, and meteorology too are still in the inductive stage and require to be so treated. The primary requirement of the day is coördination of facts without too much guidance by hypothesis that may prove a will o' the wisp. In one sentence Mr. H. G. Wells is put on one side as an unscientific writer; but, however unscientific he may be, he does stand for coördinated facts as the preliminary of social as of scientific theory; and if the authors could have seen their way to marshaling the ascertained facts of meteorology, geology, astronomy, and the other sciences pertinent to their inquiry in some encyclopedic manner easy of reference they would have made their books easy to read and refer to—much more so than is possible with a streaky alternation of fact and hypothesis in a many-folded sandwich. The shelves of meteorological libraries are already loaded with books and other forms of contribution to meteorological literature that have left no impress upon the science at all comparable with the effort necessary to produce them. That is particularly the case with books that arrange their facts according to their theory. It will be a matter of great regret if that should be the fate of "Climatic Changes" and its introductory volume "Earth and Sun."

Here we tender an apology for what may appear to the reader to be an unnecessarily critical attitude towards a work of profound interest and of great difficulty. It would certainly have been out of place if it had been possible for the vast subject to be more fully worked out. If, for example, the data had been sufficient for the authors to make out a detailed synthetic curve of the same kind as that which represents the changes due to stellar influences[10] but so that the changes of climate of the past two thousand or four thousand years could also have been represented in detail somewhat similar to Douglass' curve of tree growth, then any apparent imperfections of method would have had to give way to the logic of conclusions that are verified so far as facts are available for the purpose; but the authors themselves could hardly have regarded it as a compliment to postpone consideration of their theory until they had completed so formi-

[10] Climatic Changes, p. 279.

dable an undertaking. That would mean the shelving of the subject perhaps for a lifetime. They are themselves looking at the questions from the point of view of a tentative hypothesis which has hardly advanced so far as to be called a working hypothesis, and in the circumstances the methods rather than ascertained results must be the subject of critical consideration.

It is very desirable that geographers, geologists, astronomers, electricians, biologists, and meteorologists should be made aware that each requires the assistance and coöperation of the others; that in solving their own problems they contribute also to the solution of those of others. The amount of material that is embodied in the twenty-nine chapters is immense; and drawn from the authorities of so many different sciences the compilation represents a very useful as well as arduous task. The authors frankly ask for further investigation upon many points upon which there is at present no conclusive evidence. May we close this notice after the manner of "capping verses" by starting a hare of our own raising, for them to hunt. The cover in which it was put up is their chapter on the climate of history. It is this: By how much would it be necessary to increase the cloudiness of the region known as the "roof of the world" in Asia in order to cause famine in "the world as known to the ancients"? And in asking their acceptance of that small repayment in kind, we express our warm thanks to them for having invited and provoked a good many hours of strenuous thought on the interesting subjects which go to account for the earth's evolution.

NOTE ON THE PROGRESS OF DR. HAMILTON RICE'S SOUTH AMERICAN EXPEDITION

The plans for Dr. Hamilton Rice's expedition to the upper waters of the Branco and Orinoco Rivers were published (with a map) in the January, 1925, number of the *Geographical Review* (pp. 115–122). Some particulars of the progress of the expedition have been received in a letter from Dr. Rice to the Society dated Boa Vista, Upper Rio Branco, November 6, 1924.

Manáos was reached July 23. On this day revolution broke out. However, the plans of the expedition were in no wise affected. On the contrary everything was done to facilitate matters, and on every hand the characteristic Brazilian courtesy and helpfulness were met.

Vista Alegre, a hamlet on the left bank of the Rio Branco some 200 miles north of the point where it enters the Negro, or some 400 miles by water from Manáos, was selected as the site of the first base camp. The entire party and equipment were transported thither by the river steamer *Parahyba*, which also acted as mother ship for the hydroplane. Manáos was left August 20, and Carvoeira, near the mouth of the Rio Branco, was reached August 25. The following day the Rio Amajahú was ascended in the launch *Eleanor II*. This arm, which is about 40 miles long, branches from the Rio Xeriuhiry just before the latter enters the Rio Branco 25 miles or so above the main mouth, a feature incorrectly shown on all maps. On August 27 the main river was descended, and the Rio Negro was entered by the upper Mari-Mari passage. The three mouths are now correctly mapped.

On August 29 news was received on the Parahyba by wireless of the reduction of Obidos by Brazilian warships and of their passage to Manáos. The base camp was reached September 7. Here Mrs. Rice decided to return to the United States with Dr. and Mrs. Strong and other members of the Harvard School of Tropical Medicine unit who had completed their observations and collections in the Amazon Valley. On the return to Manáos Dr. Rice was detained for a considerable time over various matters, including repairs to the launch and the making of arrangements for the Venezuelan expedition complementary to his own. It was planned that the two sections should meet at the Serra Parima early in January. Manáos having been left again on October 12, travel was limited to daylight for the continued mapping (for the fifth time) of the intricate series of *paranas* and islands of the Anavilhana section of the Rio Negro. Vista Alegre was reached October 20.

On October 8 at Vista Alegre Dr. Koch Grünberg died of malignant malaria. Dr. George Shattuck, medical officer of the expedition, was in

attendance. The death of this distinguished ethnologist[1] was a most serious loss. He had had 25 years experience in exploration of tropical America, and great reliance had been placed on his knowledge of the territory.

From September 11 John W. Swanson at Boa Vista had been working night and day in the construction single-handed of the base radio station designed to send out as well as to receive messages. After seven weeks of hard and discouraging work the station was put into successful operation. Experience indicates that a trained wireless expert is indispensable to the topographical section of an expedition if a thoroughly reliable and accurate series of longitudes is to be obtained. An idea of the difficulties surrounding such work may be gained from the account of P. K. Boulnois and C. J. Aston ("Field-Longitudes by Wireless") in the *Geographical Journal* for April, 1924. The expedition hopes to maintain communications with Boa Vista up to the end of the journey to the Serra Parima, a difference in longitude of three degrees or more.

From the time of the expedition's departure from Manáos the proposed aerial photography has been consistently carried on by Captain A. W. Stevens. A valuable series of photographs has been secured from the Amazon up the Rio Negro to beyond Carvoeira and for the whole length of the Rio Branco. Captain Stevens has also done excellent work in map-sketching from the plane. He has an admirable team mate in Walter Hinton, the hydroplane pilot.

An important reconnaissance trip by hydroplane was made from Boa Vista on November 3. Leaving the station at 8 A. M., the plane followed the Rio Branco to the north, a landing being made at São Marcos, a hamlet near the ancient fort of São Joaquim formerly commanding the junction of the Uraricuera and Tacutu. Flight was resumed up the Uraricuera to Aparecido, a post consisting of a couple of houses only, where supplies for the expedition had already been forwarded. Thence Santa Rosa was made, at the eastern end of the large island of Maracá, which marks the last outpost to the west of the open grazing country over which roam thousands of half-wild cattle. Santa Rosa was reached at 2 P. M. The next day the plane left at 6.15 A. M., rapidly attaining a height of 5500 feet and an estimated speed of 90 miles an hour.

The southern *furo*, or channel, of the Uraricuera was followed to a point near the western end of Maracá Island when steadily increasing narrowness and clouds of mist from the many water bodies and streams made Hinton apprehensive as to whether this channel might not prove a cul-de-sac. He changed the course abruptly to the north flying over the densely forested island for ten miles until the larger northern channel was espied and westing again resumed, when it was soon seen that had the original course been held the western end of the island would have been reached. The southern *furo* is a series of boiling *caxoeiras* bordered by impenetrable,

[1] See the obituary notice in this number of the *Geographical Review*.

seemingly endless forest. For almost 50 miles farther west rapids and rocks continue to preclude the possibility of any hydroplane landing. Stevens declared that only once before in his flying experience had the terrain given rise to such a feeling of awe as that created by this savage wilderness—his flight during the previous year over the Grand Canyon of the Colorado, the Black Canyon, and Death Valley. Beyond, quiet waters flow with unbroken stretches suitable for landing purposes to the point reached on this trip, some 120 geographical miles as the crow flies short of the goal of the expedition. At 9.15 A.M. the plane was back, and landing was effected within four miles of Santa Rosa at a neighboring *fazenda*. Stevens worked on his sketch map a traverse from the hydroplane on the scale of 1:250,000. At noon the party was at Santa Rosa and, leaving this point at 3.06 P.M., reached Boa Vista at 5 P.M.

Reconnaissances and traverses have thus been carried by plane to within 120 geographical miles of the Serra Parima. The Rio Branco has been mapped on a scale of 1:250,000 from its mouths to the union of its component streams, the Uraricuera and Tacutu. Fixed points have been determined by many sets of astronomical observations for latitude and longitude obtained by Weld Arnold, assisted by Charles Bull, using the methods described in the plans for the expedition in the January number of the *Geographical Review* (pp. 117–118).

A wireless message received on January 28 reports that by January 19 the expedition had reached a point 3° 20′ N. latitude and 61° 55′ W. longitude, estimated at some 30 days from the mouth of the Parima River. It was anticipated that progress would continue to be slow for several days, but more favorable conditions were believed to exist farther on.

A wireless message dated February 24 reads: "Flight yesterday brought hydroplane within 100 miles of summit of Parima Range. One more flight will take to summit and complete aerial mapping. Present location 3° 50′ N. latitude, 63° 50′ W. longitude. Elevation river 1000 feet above sea level. Great difficulty bringing forward gasoline for return trip hydroplane. Supply at present over 100 miles behind it."

AN AID TO TRIANGULATION

THE USE IN SECONDARY TRIANGULATION OF SIMPLE FIGURES HAVING AN EXTERIOR POLE

By O. M. Miller

American Geographical Society's School of Surveying

As a preliminary to making a map a number of fixed points must be located in order to supply the necessary control for the detailed survey. This is done by measuring a trigonometrical framework or triangulation net over the country to be mapped. In respect to this, two main types of difficulties have to be confronted; firstly, the problem of choosing observation stations in such relative positions to one another that the resulting triangulation net is strong and capable of a rigorous adjustment and secondly, the problem of doing this quickly and economically. Unfortunately, the time and money question is usually the governing factor; and in making a choice the best scheme theoretically is nearly always discarded for a scheme not quite so good but considerably more economical.

With these considerations in view, in modern practice it is usual, except when operations of the most precise nature are contemplated, to restrict the triangulation net to a chain of consecutive simple figures, in which adjacent figures have only one side in common.

As a result the number of observations made is reduced to a minimum, and the labor of the adjustment of observation errors is very much lessened. However, this all adds to the difficulties of choosing the most suitable scheme in the first place, especially as the types of triangulation figures considered good practice are distinctly limited.

Supposing another type of simple figure could be found which would fulfill the necessary theoretical and practical requirements and which at the same time could be used in circumstances that debar the standard types of figure, then by utilizing this figure judiciously the difficulties of the initial reconnaissance should be lessened and the triangulation as a whole might possibly be executed more efficiently and economically than otherwise. It is the purpose of this paper to discuss such a figure, namely a polygon with an exterior pole. It is aimed to demonstrate that this simple figure may be adjusted easily by approximately rigorous methods; that the use of the tetragon with an exterior pole may be of real practical value to the surveyor engaged in secondary triangulation; and that this practical usefulness would not be likely in the case of a simple figure with an exterior pole composed of more than five stations.

Consequently, general rules for the adjustment of any simple figures are given, and it is shown how these may be applied to the particular case

of a tetragon with an exterior pole. Examples are given of the use of such figures under particular circumstances, and an endeavor has been made to arrive at a conclusion as to their relative value by a comparison of their theoretical weight with that of more conventional simple figures under similar conditions.

Simple Triangulation Figures

ADJUSTMENT BY SUCCESSIVE APPROXIMATIONS

In primary geodetic surveying the errors of observation in a triangulation net are adjusted rigorously by the method of least squares; but in secondary work, where a larger margin of error is permissible, simple independent figures may be adjusted with sufficient accuracy by successive approximations, and the results differ but little from those obtained by a rigorous adjustment.

In the adjustment of any triangulation figure there are always two distinct types of conditional equations—the angle and side equations.[1]

In the approximately rigorous adjustment by successive approximations the angle equation adjustment is made first, and then with the corrected angles a solution of the side equation is made. The latter adjustment will generally slightly disturb the former adjustment, and the whole process must then be repeated with the resulting angles until both types of equation have been satisfied with sufficient accuracy.

This method of adjustment is confined, as a rule, to simple independent figures. A general definition of a simple figure is that it consists of a polygon to the corners of which rays have been drawn from a pole. The important characteristic of such a figure is that it involves in its adjustment only one side equation. Such figures usually take the form of a quadrilateral with both diagonals drawn, or a central pointed polygon; that is to say, a figure in which the pole is inside the area of the polygon.

This approximately rigorous method of adjusting a secondary triangulation has for many years been accepted as permissible, and most textbooks give at least a passing reference to it.[2] Lately, however, Captain G. T. McCaw has written a paper in which the subject is dealt with very fully and in such a way as to make its practical application a simple matter even to those not familiar with least-square methods.[3]

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[1] Throughout this paper it is assumed that the angles have been measured by the method of independent angles and not by the method of directions.

[2] See, for instance, the following: T. W. Wright and J. F. Hayford: The Adjustment of Observations by the Method of Least Squares with Applications to Geodetic Work, 2nd edit., New York, 1906, Section 131 (pp. 177–179).

E. L. Ingram: Geodetic Surveying and the Adjustment of Observations (Method of Least Squares), New York and London, 1911, Section 59 (pp. 92–96).

J. B. Johnson and L. S. Smith: The Theory and Practice of Surveying, 17th edit., New York, 1910, Section 454 (p. 614).

E. R. Cary: Geodetic Surveying, New York, 1916, Section 60 (pp. 79–81).

[3] G. T. McCaw: Approximately Rigorous Adjustment of Simple Figures, *Geographical Section, General Staff, Technical Paper No. 1*, War Office, London, 1919.

A POLYGON WITH AN EXTERIOR POLE

In discussing the case of a central pointed triangle, Captain McCaw says, "This figure containing four stations is obviously a special case of the quadrilateral." It might, however, be said that the quadrilateral with both diagonals drawn is a special case of the central-pointed triangle, except that the central point, or pole, has been projected outside the area of the triangle (see Figs. I and II).

In practice, a closed quadrilateral is the kind of simple figure most frequently employed, but as far as the writer can ascertain, a figure with an exterior pole, consisting of five stations, has never been considered with a view to its adjustment by approximately rigorous methods. It is doubtful whether such a figure having six or more stations could be used

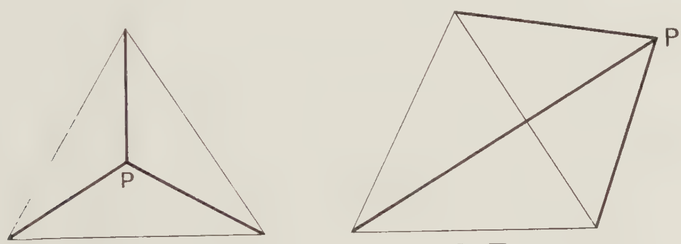


Fig. I. Fig. II.

to practical advantage in the field, because it is generally possible, where such a number of stations is to be employed, to build up a triangulation net as economically and with greater precision, composed of two contiguous simple figures (see Figs. III and IV and p. 277).

This is not the case, however, when one considers a five-pointed figure. Occasions must often occur where it is not possible to employ only one closed quadrilateral or central-pointed triangle as a particular link in the general scheme of triangulation and where the use of six stations is considered extravagant. The employment of a central-pointed tetragon is a conventional way out of the difficulty, but it is quite probable that local conditions could make even this arrangement impracticable. It is suggested that the use of a tetragon with an outside pole might on occasion solve the problem (see Figs. V, VI, and VII).

RULES FOR ADJUSTMENT

However, before discussing this type of figure it would be as well to devise some system of numbering the angles that is equally applicable to any simple figure and to summarize the rules for adjusting any such figure by the approximately rigorous method.

Suppose the polar station of any simple figure is lettered P, and the

sides of the closed polygon are lettered $AB–BC–CD$. . . . . ., consecutively. The side equation may now be expressed in terms of the sides:

$$\frac{PB}{PA}\ \frac{PC}{PB}\ \frac{PD}{CP}\ \cdots\cdots\cdots\cdots\ \frac{PA}{PN} = 1.$$

As the sides of a triangle are proportional to the sines of their opposite angles, the side equation can be expressed in terms of the angles:

$$\frac{(\text{Sin } A}{(\text{Sin } B} \text{ in the } \triangle\ PAB) \times \frac{(\text{Sin } B}{(\text{Sin } C} \text{ in the } \triangle\ PBC) \ldots = 1.$$

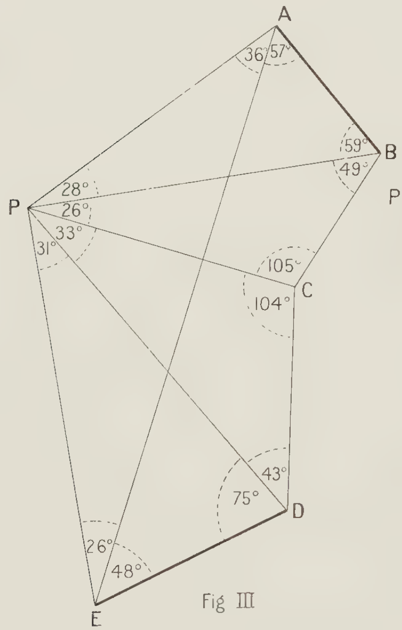


Fig III

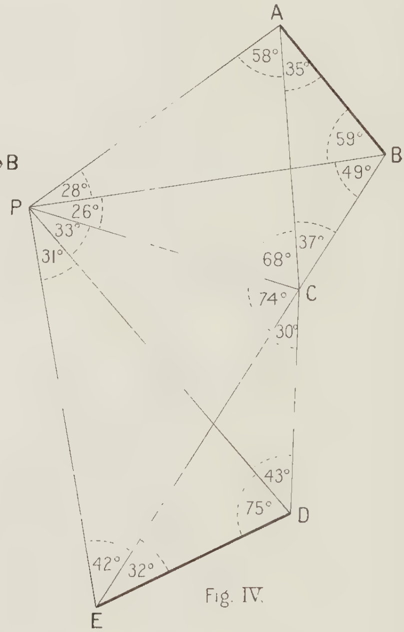


Fig. IV.

Number the angles so that the side equation can now be written:

$$\frac{\text{Sin } 1}{\text{Sin } 2} \times \frac{\text{Sin } 3}{\text{Sin } 4} \times \cdots\cdots\cdots\cdots = 1.$$

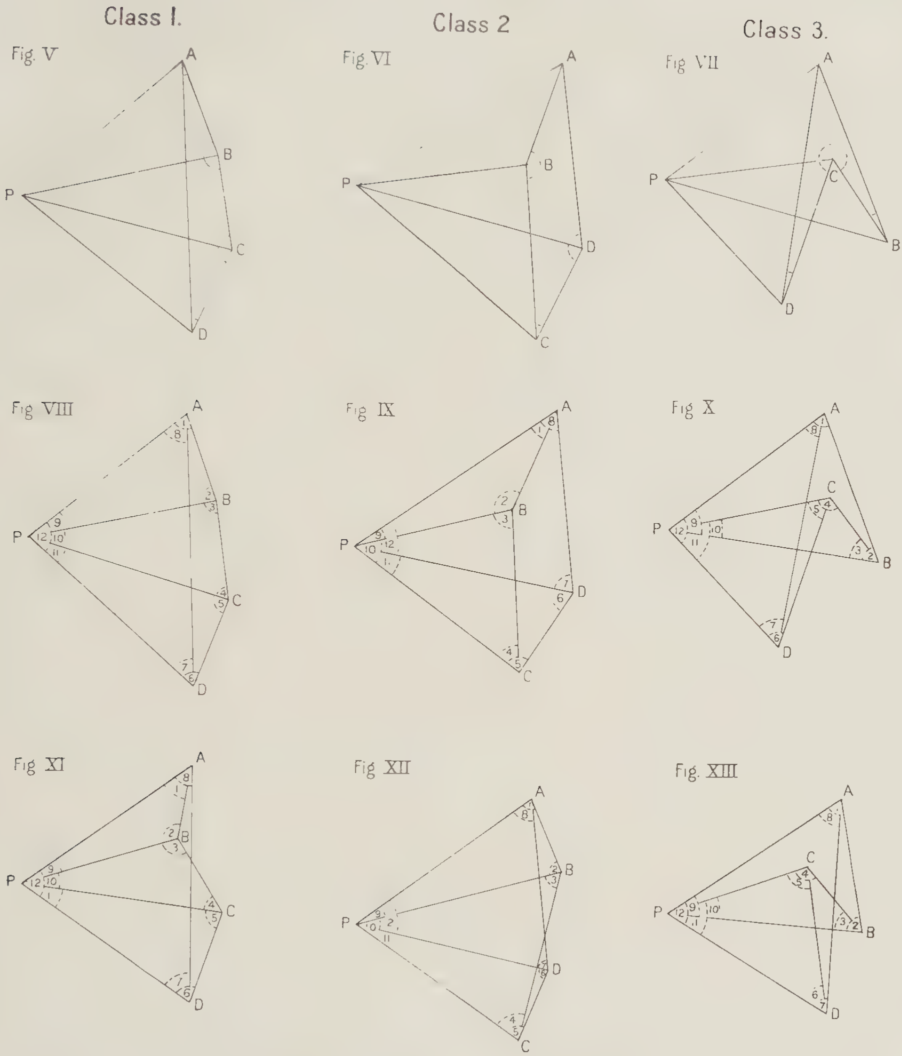
The angles at the pole are then numbered so that the first in order is the supplement of 1 and 2, and the second is the supplement of 3 and 4, and so on.

It is convenient to call the angles at the pole "polar angles," and the other numbered angles "side angles."

To solve the angle equations: If C_1, C_2, C_3, ...are the triangular errors, F the figural closing error, n the number of triangles in the figure, and x_1, x_2, x_3, . . .the total corrections to be applied to the angles 1, 2, 3, etc., respectively,

then the x correction to a side angle $= \frac{1}{3} C + \frac{1}{6}\frac{F}{n}$ . . . . (1)

and " " " " " polar " $= \frac{1}{3} C - \frac{1}{6}\frac{F}{n}$ . . . . (2)



Before making this adjustment it is essential that the polar angles be consistent one with another. For instance, in the case of a central-pointed polygon the polar angles should sum up to 360°. This condition may be called the polar-station equation.

To solve the side equation: If l is the difference between the sums of the log sines of the even side angles and the odd side angles, and if δ_1, $\delta_2 \ldots\ldots \delta_n$ are the differences for one second of arc in the log sines extracted for each angle, then $l/\Sigma\delta^2$ is a constant factor which, when multiplied by the δ of any angle, will give the correction in seconds of arc to be applied to this angle.[4]

[4] In the case of the closed quadrilateral the pole might be any one of the four observation stations, and, such being the case, the above rules would be applicable. However, in practice, the pole is taken as the point of intersection of the diagonals, and special rules have been devised for its approximately rigorous adjustment.

A Tetragon with an Exterior Pole

THREE CLASSES DEFINED

In the approximately rigorous adjustment of a tetragon with an exterior pole the preceding rules are theoretically applicable. However, for the purpose of solving the angle equations it is convenient to group this figure into three main classes (see Figs. V, VI, and VII) dependent on the manner in which the four triangles group themselves about the pole. It will be demonstrated later that these three classes indicate the three possible forms in which the conditions of figural closure for the remaining four stations can be expressed.

Number Figures VIII, IX, and X in the systematic manner previously suggested,

$$\text{then}\left\{\begin{array}{llll}\text{in Fig. VIII} & \text{angles} & 9+10+11-12=0 & (\text{Class } 1)\\ \text{`` \quad `` \quad IX} & \text{``} & 9+10-11-12=0 & (\text{`` \quad } 2)\\ \text{`` \quad `` \quad X} & \text{``} & 9-10+11-12=0 & (\text{`` \quad } 3)\end{array}\right\}\begin{array}{c}\text{polar station}\\ \text{equations.}\end{array}$$

It is difficult at first glance to place Figures XI, XII, and XIII in their correct classes, but once the side equations have been formed, and the angles numbered in the manner stated, it will be apparent that these figures can be placed in Classes 1, 2, and 3 respectively.

ANGLE EQUATIONS

It is possible to express the conditions of figural closure for these types of figure by the following equations:

Class 1: angles $1+2+3+4+5+6-7-8 = 360°$ ....(3)
Class 2: angles $1+2+3+4-5-6-7-8 = 0$ ....(4)
Class 3: angles $1+2-3-4+5+6-7-8 = 0$ ....(5)

That these equations are true and equally applicable to either Figures VIII or XI in Class 1, and either Figures IX or XII in Class 2, and, again, to either Figures X or XIII in Class 3 can be easily proved.

It will be quite sufficient to demonstrate this fact with a single example.

Suppose Figures IX and XII, both in Class 2, are examined.

In Figure IX the figural closure of the points A, B, C, D can be expressed in the form:

$$\text{angles } DAB + ABC + BCD + CDA = 360° \quad \ldots\ldots\ldots\ldots(6)$$

but the angle DAB = angles $(8-1)$
" " ABC = " $360° - (2+3)$
" " BCD = " $(5-4)$
and " " CDA = " $(6+7)$.

Therefore, substituting in equation (6),

$$\text{angles } 8-1+360°-2-3+5-4+6+7 = 360°$$

and, by rearranging,

$$\text{angles } 1+2+3+4-5-6-7-8 = 0 \quad \ldots\ldots\ldots\ldots(7)$$

Again, in Figure XII, the figural closure of the points A, B, C, D can be expressed in the form:

$$\text{angles } DAB + ABC = \text{angles } BCD + CDA \ldots\ldots(8)$$

$$\begin{array}{lll} \text{but the angle } DAB & = & \text{angles } (1 - 8) \\ \text{“} \quad \text{“} \quad ABC & = & \text{“} \quad (2 + 3) \\ \text{“} \quad \text{“} \quad BCD & = & \text{“} \quad (5 - 4) \\ \text{and “} \quad \text{“} \quad CDA & = & \text{“} \quad (6 + 7). \end{array}$$

Therefore, substituting in equation (8),

$$\text{angles } 1 - 8 + 2 + 3 = \text{angles } 5 - 4 + 6 + 7,$$

and, by rearranging,

$$\text{angles } 1 + 2 + 3 + 4 - 5 - 6 - 7 - 8 = 0 \ldots\ldots\ldots\ldots\ldots(9)$$

It will be apparent that equations (7) and (9) are similar to equation (4).

ADJUSTMENT BY SUCCESSIVE APPROXIMATIONS

Having got thus far, it is now possible to frame more detailed rules for the solution of the angle equations in the three classes of this figure.

Previous to making the adjustment as a whole it is essential that the polar-station equation be satisfied (see p. 271).

Now, in the notation as previously used, if C_1, C_2, C_3, and C_4 are the corrections to the closures of the triangles PAB, PBC, PCD, and PDA, respectively, and F is the correction to the figural closure of the stations A, B, C, D; and again, if $x_1, x_2, \ldots x_{12}$ are the corrections to each individual angle 1 to 12 in that order, then the following rules for the solving of the angle equations can be stated in tabulated form as in Table I.

TABLE I

x Correction	Applicable to all Classes	Class 1	Class 2	Class 3
$x_1 = x_2 =$	$+\frac{1}{3}C_1$	$+\frac{1}{24}F$	$+\frac{1}{24}F$	$+\frac{1}{24}F$
$x_3 = x_4 =$	$+\frac{1}{3}C_2$	$+\frac{1}{24}F$	$+\frac{1}{24}F$	$-\frac{1}{24}F$
$x_5 = x_6 =$	$+\frac{1}{3}C_3$	$+\frac{1}{24}F$	$-\frac{1}{24}F$	$+\frac{1}{24}F$
$x_7 = x_8 =$	$+\frac{1}{3}C_4$	$-\frac{1}{24}F$	$-\frac{1}{24}F$	$-\frac{1}{24}F$
$x_9 =$	$+\frac{1}{3}C_1$	$-\frac{1}{12}F$	$-\frac{1}{12}F$	$-\frac{1}{12}F$
$x_{10} =$	$+\frac{1}{3}C_2$	$-\frac{1}{12}F$	$-\frac{1}{12}F$	$+\frac{1}{12}F$
$x_{11} =$	$+\frac{1}{3}C_3$	$-\frac{1}{12}F$	$+\frac{1}{12}F$	$-\frac{1}{12}F$
$x_{12} =$	$+\frac{1}{3}C_4$	$+\frac{1}{12}F$	$+\frac{1}{12}F$	$+\frac{1}{12}F$

With regard to the side equation adjustment of the tetragon with an exterior pole, it is sufficient to state that the general rules already given apply equally well to this as to any other type of simple figure.

PRACTICAL APPLICATIONS

It is suggested that the inclusion of the type of figure under discussion into the list of simple figures capable of a semi-rigorous adjustment, much

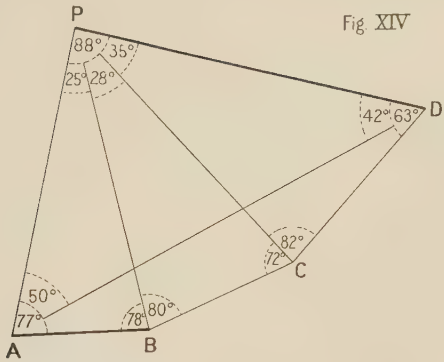


Fig. XIV

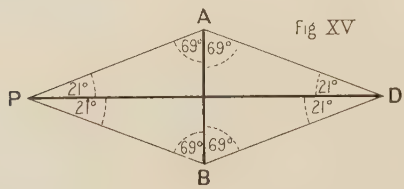


Fig. XV

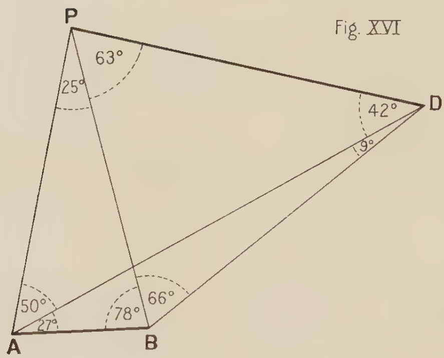


Fig. XVI

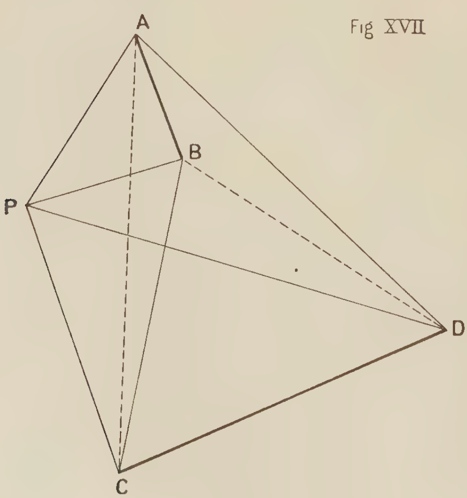


Fig. XVII

time, labor, and expense may be occasionally saved by its judicious use and that, furthermore, under certain circumstances its use might form the only practical solution to an otherwise intractable problem.

Example I (see Fig. XIV).—*AB* is a proposed base line, situated on the meander lobe of a flood plain. The river valley's general direction is at right angles to the base itself.

For the purpose of actual measurement the situation of *AB* is ideal, it being flat, even meadow land. However, there are difficulties in the way of extending the base to the main triangulation, as very few points on the surrounding upland can be seen from both ends of the base.

The point *P*, upstream from and therefore approximately at right angles to *AB*, is found to be a suitable station, but, owing to intervening low ground downstream, no such point can be chosen on the other side of the base to enable the extension to take the usual form of a closed quadrilateral.

A point, *C*, is found which can be seen from both ends of the base and also from *P*, but its position has obvious disadvantages, for if a closed quadrilateral is formed of the points *A*, *B*, *C*, and *P*, the angles *ACB* and *BAC* will be badly conditioned.

Another point, *D*, is found, but in this case, as its position is farther away from the edge of the valley, it and *B*, the nearest end of the base from it, are not mutually visible.

PD, however, would form a very desirable extension from the base, as it would fit in well with the main scheme of the triangulation. If the surveyor has directions to limit the scheme of triangulation to a network of simple independent figures, such as the quadrilateral and the central-pointed polygon, in this case he would be in a quandary and would probably have to discard the base *AB* for one not so suitable from a measurement point of view. However, the solution of the difficulty is simple and satisfactory if he decides to use all five points *A*, *B*, *C*, *D*, and *P* and make as his figure a tetragon with an exterior pole.

In this case *A*, *B*, *C*, and *D* are the four corners of the tetragon from which rays are drawn to the pole, *P*. From the way in which the triangles group themselves about the point *P*, it will be noticed that the figure is in Class 1. These four triangles are all comparatively well conditioned, the smallest angle, *APB*, being over 25° and the largest angle, *APD*, being under 90°. Now, the ratio of the base, *AB*, to the extension, *PD*, is approximately 3 to 8.

Example II (see Fig. XVII)—*AB* is the first extension of a small check base. It is desired to extend *AB* to *CD*, *C* and *D* being two stations in the main triangulation. Now, it is possible to connect up the points *A*, *B*, *C*, *D* in such a way as to form a central-pointed triangle with *B* as center; but, if this were done, most of the observed angles would be badly conditioned. Again, by choosing two more stations it would be possible to extend from *AB* to *CD* through two well conditioned quadrilaterals. This scheme, however, would greatly increase the field and computing work. A satisfactory compromise is therefore made by choosing a station, *P*, such as is visible to all the other stations *A*, *B*, *C*, and *D*. The stations are connected together, as shown in the figure, and again a "tetragon with an outside pole" is formed, this time belonging to Class 2.

RELATIVE WORTH

In order to arrive at some conclusion as to the relative worth of a tetragon with an outside pole, it would seem advisable to obtain a formula for expressing the weight of a simple figure.

Apart from the precision with which the angles have been measured, the relative weight of the finally adjusted side computed through a single chain of triangles in a triangulation net from a known base may be expressed by the formula[5]

$$w = \frac{3}{2} \cdot \frac{n \times nc}{(n - nc)} \cdot \frac{1}{\Sigma(\delta_A^2 + \delta_A\delta_B + \delta_B^2)},$$

where n is the number of independently observed angles, n_c is the number of conditions that must be satisfied in the figure, and δ_A, δ_B are the differences of one second of arc in the log sines of the angles opposite the known side and the computed side in each triangle.

[5] The derivation of this formula is given in Appendix I.

Assuming that in a simple figure each "side" angle has been observed independently and that one of the "polar" angles is locally dependent on the others, then, where S equals the number of stations,[6]

$n = 3S - 4$

$n_c = S.$

Therefore, in the case of simple figures, the term

$$\frac{3}{2} \cdot \frac{n \times n_c}{(n - n_c)}$$

has values as shown in Table II.

TABLE II

(*A*) Number of Stations S	(*B*) $\frac{3}{2} \cdot \frac{n \times n_c}{(n - n_c)}$	Ratio $\frac{(B)}{(A)}$
4	12.00	3.00
5	13.75	2.75
6	15.75	2.625
7	17.85	2.55
8	20.00	2.50

The formula under discussion gives, however, only the weight of the finally computed side through a particular chain of triangles. What is wanted, in order to obtain the relative worth of different triangulation nets under similar conditions, is the weight of the net as a whole.

Obviously, it would not be correct to assume that this can be assessed simply by considering the best chain of triangles in each case, because theoretically the most probably correct determination of the finally computed side would be the weighted mean of all the results computed through each chain of triangles. Nevertheless, this statement assumes that the stronger the chain of triangles, the more influence it should have in determining the mean result. Consequently, in order to obtain the weight of the figure as a whole, rather than take the simple mean of the weights of each chain, the more correct procedure would be to take the weighted mean of these weights.

Therefore, if W is this weighted mean and if $w_1, w_2 \ldots\ldots w_n$ are the weights of the determinations computed through the individual chains of triangles,

then $W = \frac{\Sigma w^2}{\Sigma w}.$

Suppose these formulae for weight are used to compare Figure XIV, a tetragon with an outside pole, with Figures XV and XVI, the former being a quadrilateral whose diagonals bisect each other at right angles

[6] For proof of these equations see Appendix II.

and are in the same ratio as the base AB and the extension PD in Figure XIV, and the latter a quadrilateral formed of the stations A, B, P, D, in Figure XIV.

In Figure XIV there are two chains of triangles through which the length PD is computed from the length AB, and in each of the other figures there are four different ways of doing the same thing.

The results of these comparisons are shown in Table III.[7]

TABLE III

	Weight of Finally Computed Side Through Single Chain of Triangles		Weight of Figure $W = \frac{\Sigma w^2}{\Sigma w}$	Weight per Station of Figure $\frac{W}{S}$
Fig. XIV	w_1 =	5.50	4.85	0.97
	w_2 =	3.93		
	w_1 =	3.87		
Fig. XV	w_2 =	3.87	3.87	0.98
	w_3 =	3.87		
	w_4 =	3.87		
	w_1 =	4.30		
Fig. XVI	w_2 =	3.43	3.40	0.85
	w_3 =	1.00		
	w_4 =	0.56		

Again, as evidence of the comparative weakness of a simple figure with an exterior pole and composed of more than five stations (see p. 269) suppose Figure III and Figure IV are compared in the same way. In both figures the six stations are the same, and the finally computed side DE is found from the base AB. Figure III is a pentagon with an exterior pole, and there are two chains of triangles through which DE is computed. Figure IV is composed of two independent, but contiguous, closed quadrilaterals, and in this case there are sixteen chains of triangles.

The results of this comparison are shown in Table IV.

It must be remembered, of course, that any formula for weight is a relative one and should be used only to compare figures under similar conditions.

In conclusion, the writer gratefully acknowledges his indebtedness to Captain McCaw for suggesting the initial formula for determining the weight of the finally computed side through a single chain of triangles, and for other help in connection with the latter part of this paper.

[7] Note that in determining the results contained in Tables III and IV the unit for the values of the expression $\Sigma(\delta_A^2 + \delta_A\delta_B + \delta_B^2)$ has been taken as one in the fifth place of logarithms.

TABLE IV

	$w_1 \quad w_2 \ldots\ldots w_n$		W	$\frac{W}{S}$
Fig. III	$w_1 =$	4.4	3.66	0.61
	$w_2 =$	2.1		
	$w_1 =$	10.0		
	$w_2 =$	8.3		
	$w_3 =$	7.5		
	$w_4 =$	6.9		
	$w_5 =$	6.5		
	$w_6 =$	6.3		
	$w_7 =$	6.0		
	$w_8 =$	5.2		
Fig. IV	$w_9 =$	4.9	6.13	1.02
	$w_{10} =$	3.6		
	$w_{11} =$	3.2		
	$w_{12} =$	3.2		
	$w_{13} =$	3.1		
	$w_{14} =$	3.0		
	$w_{15} =$	2.7		
	$w_{16} =$	2.1		

Appendix I

DERIVATION OF THE FORMULA FOR WEIGHT USED IN THIS PAPER

The formula

$$W = \frac{3}{2} \cdot \frac{n \times n_c}{(n - n_c)} \cdot \frac{1}{\Sigma(\delta_A^2 + \delta_A \delta_B + \delta_B^2)}$$

is derived[8] from

$$\mu^2 \log a_n = \frac{2}{3} \mu'^2 . \ \Sigma (\delta_A^2 + \delta_A \delta_B + \delta_B^2),$$

where $\mu^2 \log a_n$ is the (m.s.e.)^2 of the log of the finally computed side, and

$$\mu' = \sqrt{\frac{n - n_c}{n}},\ \mu_m$$

$$\mu_m = \frac{\mu}{\sqrt{p_m}}$$

$$\mu = \sqrt{\frac{\Sigma p v^2}{n_c}}$$

Substituting in these equations,

$$\mu^2 \log a_n = \frac{2}{3} \cdot \frac{(n - n_c)}{n \times n_c} \cdot \frac{\Sigma p v^2}{p_m} \cdot \ \Sigma(\delta_A^2 + \delta_A \delta_B + \delta_B^2).$$

Assuming that the weight is inversely proportional to the square of the m.s.e., then, where w is the relative weight of a finally computed side from a known base through a given chain of triangles,

$$w = \frac{3}{2} \cdot \frac{n \times n_c}{n - n_c} \cdot \frac{p_m}{\Sigma p v^2} \cdot \frac{1}{\Sigma(\delta_A^2 + \delta_A \delta_B + \delta_B^2)} \cdot$$

[8] See Wright and Hayford, *op. cit.*, Section 174 (pp. 237–238).

Now, as the formula required is for the weight apart from the precision with which the observations have been made, the term $\frac{pm}{\Sigma pv^2}$ should be discarded.

Then

$$w = \frac{3}{2}\cdot\frac{n \times n_c}{(n-n_c)}\cdot\frac{1}{\Sigma(\delta_A{}^2+\delta_A\delta_B+\delta_B{}^2)}.$$

The formula for the theoretical strength of a chain of triangles, as given by the U. S. Coast and Geodetic Survey,[9] is

$$R = \frac{n-n_c}{n}.\ \Sigma(\delta_A{}^2 + \delta_A\delta_B + \delta_B{}^2),$$

where R is the reciprocal of the strength, and the unit for the values of the expression $(\delta_A{}^2 + \delta_A\delta_B + \delta_B{}^2)$ is one in the sixth place of logarithms.

It will be observed that this formula is derived from the same source as the one already employed and by comparison it will be found

$$\text{that } R = \frac{15n_c}{w}.$$

Therefore those who prefer to use the U. S. C. & G. S. formula and to think in terms of R may do so by dividing $15n_c$ or $15s$ by the values of the various w_1 and w_2 given in Tables III and IV, thereby obtaining corresponding values of R_1 and R_2.

Appendix II

SIMPLE FIGURES: THE NUMBER OF INDEPENDENT UNKNOWNS AND CONDITIONAL EQUATIONS IN A SIMPLE FIGURE

In all simple figures, except the closed quadrilateral, one of the observation stations is taken as the pole.

Therefore, n = number of numbered angles -1 (see p. 276)
$= 3$ (number of triangles in figure) $- 1$.

But number of triangles in figure $= S - 1$,

therefore, $n = 3(S-1) - 1$
$= 3S - 4$.

In the case of the quadrilateral the same formula applies, as, obviously, if none of the observation stations is taken as the pole, then

$$n = 2S.$$

But in this case $S = 4$,

therefore $n = 3S - 4$.

When all lines (l) in a figure[10] have been observed over in both directions the number of side equations $= l - 2S + 3$. But in a simple figure this is always unity,

therefore, $l = 2(S-1)$.

Now, total number of conditions $= 2l - 3S + 4$,

consequently, $n_c = 4(S-1) - 3S + 4$
$= S$.

[9] General Instructions for the Field Work of the U. S. Coast and Geodetic Survey, *Special Publication No. 26*, Washington, D. C., 1915, Section 25 (p. 12).

[10] Wright and Hayford, *op. cit.*, Section 152 (pp. 202–203).

SWEDISH LATE-QUATERNARY GEOCHRONOLOGIES

By Ernst Antevs

The principal means employed for estimating the duration of the late-glacial and post-glacial epochs in Sweden are astronomical evidences; combination of astronomical evidences and immigration and migrations of plants and animals and arrangements of their associations; archeological evidences; changes of level; and annually laminated, or varved, late-glacial and post-glacial clays.[1] Of these the varved clays evidently are foremost, since they alone make an exact geochronology possible.

Andersson's and Munthe's Chronologies

Although now discarded, Andersson's and Munthe's estimates of the duration of the late-Quaternary time should be noted if only for historical reasons. They were based upon all the evidences mentioned above except the post-glacial clay.

Andersson[2] assumed that the maximum stage of the last glaciation coincided with a minimum of temperature which in Ekholm's[3] opinion existed during the last minimum inclination of the earth's axis to the ecliptic about 28,000 years ago. The ice retreat was supposed to have begun with the assumed temperature rise 26,000 years ago. The length of the post-glacial time was estimated at some 21,000 years.

Also Munthe was inclined to connect the maximum of the last glaciation with the supposed temperature minimum 28,000 years ago; and he assumed that the uncovering of Sweden began 24,000 years and the post-glacial epoch 17,600 years ago.[4]

De Geer's Late-Glacial Chronology

Using the seasonally banded, or varved, clays deposited in front of the receding ice borders De Geer worked out a chronology of the last ice reces-

[1] Late-glacial time according to the Swedish geochronology is the time from the beginning of waning of the last ice sheet to the bisection of the ice remnant, when the eastern ice edge stood at Stugun 38 kilometers (23½ miles) west of Ragunda (63° N.) in northern Sweden. Post-glacial time is the time after the bisection. The cutting through was accompanied by catastrophic drainage of the lake dammed on the west side of the ice and is thus recorded by a thick varve. For further information see, for instance, Ernst Antevs: On the Late-Glacial and Post-Glacial History of the Baltic, *Geogr. Rev.*, Vol. 12, 1922, pp. 602–612.

[2] Gunnar Andersson: The Climate of Sweden in the Late-Quaternary Period, *Sveriges Geol. Undersökning*, Ser. C, No. 218 (Arsbok 3, 1909, No. 1); reference on p. 39.

[3] Nils Ekholm: Om klimatets ändringar i geologisk och historisk tid samt deras orsaker, *Ymer*, Vol. 19, 1899, pp. 353–403.

Idem: On the Variations of the Climate of the Geological and Historical Past and Their Causes, *Quart. Journ. Royal Meteorol. Soc.*, Vol. 27, 1901, pp. 1–62.

Cf. W. Köppen: Das System in den Bodenbewegungen und Klimawechseln des Quartärs im Ostseebecken, *Zeitschr. für Gletscherkunde*, Vol. 12, 1922, pp. 97–123; reference on pp. 118–122.

[4] Henrik Munthe: Studier öfver Gottlands senkvartära historia, *Sveriges Geol. Undersökning*, Ser. Ca., No. 4, 1910; reference on pp. 205 and 206.

Idem: Studies in the Late-Quaternary History of Southern Sweden, *Geol. Fören. Förhandl.*, Vol. 32, 1910, pp. 1197–1293; reference on pp. 1210–1213.

sion in Sweden.[5] Both the method and the history of the investigation are so well known that it is here sufficient merely to refer to De Geer's papers.[6] The method is the only accurate one there is. If clay exposures are frequent and contain great numbers of distinct and undisturbed varves, and if the work is carefully and critically carried out, the error may be brought down to less than one year in one hundred. However, De Geer's studies are not yet finished. The latest publication is a map in 1 : 10,000,000 with lines roughly indicating the positions of the ice front every 500 years. The ice retreat from the central parts of the Danish Islands up to Ragunda in Norrland (63° N.) is found to have taken about 5000 years. The time of the uncovering of Denmark and southwestern Scania, however, may be much underestimated.[7] During the last ten years De Geer has essentially presented preliminary reports on different detailed studies and on connections established over long distances.[8]

Lidén's Post-Glacial Chronology

Deposition of varved late-glacial clays evidently ceased when the ice sheet vanished; but their function as a register of years was continued without a break by a seasonally banded clay silt deposited in the fiords of northern Sweden. This clay silt, first studied by Lidén in the valley of the river Ångermanälven (63° N.), is thinly laminated on the whole, and the two zones representing the annual deposition show but slight difference in grain size and color.[9] The light-gray silt layer is deposited in the spring season when the rapid melting of the snow causes river floods. The fine-grained, clayey, dark-gray zone, the equivalent of the winter layer in the late-glacial clay, is formed during low water.

When the ice first withdrew from central Norrland that region stood as much as 280 meters (920 feet) lower than now in relation to the Baltic. In post-glacial time it has been subject to an uninterrupted rise down to the

[5] Gerard De Geer: A Thermographical Record of the Late-Quaternary Climate: Die Veränderungen des Klimas seit dem Maximum der letzten Eiszeit, Eine Sammlung von Berichten . . . herausgegeben von dem Exekutivkomitee des 11. Internatl. Geologenkongresses, Stockholm, 1910, pp. 303–310.

Idem: A Geochronology of the Last 12,000 Years, *Compte Rendu Congrès Géol. Internatl. XI, Stockholm, 1910*, Stockholm, 1912, pp. 241–253.

Idem: Om naturhistoriska kartor över den baltiska dalen, *Pop. Naturvet. Revy*, 1914, pp. 189–200, Stockholm.

[6] See also Ragnar Sandegren: Den kvartärgeologiska forskningen i Sverige under de senaste 25 åren, *Geol. Fören. Förhandl.*, Vol. 43, 1921, pp. 119–156.

Ernst Antevs: The Recession of the Last Ice Sheet in New England, *Amer. Geogr. Soc. Research Series No. 11*, 1922.

[7] Ernst Antevs: On the Pleistocene History of the Great Basin, in *Carnegie Instn. Publ. No. 352* (in press).

Idem: The Retreat of the Last Ice Sheet in Eastern Canada, *Geol. Survey of Canada Memoir* (in press).

[8] For Gerard De Geer's publications up to October, 1918, see Ebba Hult De Geer: Bibliographia De Geeriana, *Geol. Fören. Förhandl.*, Vol. 40, 1918, pp. 809–852.

Gerard De Geer: Geokronologiala relato inter la Alpala e la Skandinava glaciaci, *ibid.*, Vol. 41, 1919, pp. 227–233.

Idem: On the Determination of Geochronology by a Study of Laminated Deposits, *Science*, Vol. 52, (N. S.), 1920, pp. 502–503.

Idem: Correlation of Late-Glacial Clay Varves in North America with the Swedish Time Scale, *Geol. Fören. Förhandl.*, Vol. 43, 1921, pp. 70–73.

Idem: Nordamerikas kvartärgeologi belyst av den svenska tidskalan, *ibid.*, Vol. 43, 1921, pp. 497–499.

[9] Ragnar Lidén: Om isafsmältningen och den postglaciala landhöjningen i Ångermanland, *Geol. Fören. Förhandl.*, Vol. 33, 1911, pp. 271–280.

present. As a consequence the mouths of the rivers and the areas of sedimentation have gradually moved outwards, and the deposits have been raised above the water level and subsequently cut through by the rivers. So the deposits grow younger and younger, as we proceed downstream, and those of the last few hundred years are not yet raised above the level of the sea. The varved clay silts form the distal delta sediments and the most fine-grained part of the fiord deposits.

Because of this recession of the shore line, measurements have to be made from the surface downward and also down-valley. The number of varves deposited at a down-valley locality after the formation of the top varve at an up-valley locality gives the number of years required to shift the river mouth from the one point to the other. The difference in elevation between the planes of sedimentation gives the amount of land upheaval. The migration of the shore line and the sequence of strata show that the rise proceeded without interruption but at a progressively decreasing rate during the whole post-glacial epoch.

The retreat of the river mouth from the Baltic limit at an elevation of 238.5 meters (782 feet) down to Grillom, situated 21.5 meters (70.5 feet) above the present river mouth, was found to have taken 4520 years. From A. Bygdén's survey of the rise of the region during the last few centuries the upheaval of the last 21.5 meters is calculated to have taken 2040 years. The total length of the post-glacial period was thus found to be about 6560 years.

Continued field studies, finished some ten years ago, proved this figure to be too small. The material is not yet published, and to my knowledge no new figure has been publicly announced by Lidén himself. I have learned, probably through De Geer, that Lidén's final investigations give 8500 years as the duration of the post-glacial epoch in Sweden. Recently De Geer succeeded definitively in connecting Lidén's post-glacial time scale with that of the last ice retreat and so found the post-glacial time to amount to about 8800 years.[10]

Also in these new figures the time (some hundreds of years) that has elapsed since the deposition of the youngest raised and measured varve is only estimated. However, this gap might be bridged by the help of the climatic curve based upon the big trees (*Sequoia washingtoniana*) of California. It seems likely that the sequoia curve, based upon the thickness of the rings of growth, will show certain correspondence with the sedimentation curve in Norrland, which fairly accurately records the relative annual snowfall.[11] The climatic stress of the fourteenth century is distinctly

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[10] Gerard De Geer: Om den definitiva förbindelsen mellan den svenska tidskalans senglaciala och postglaciala del, *Geol. Fören. Förhandl.*, Vol. 46, 1924, pp. 493–494.

Ragnar Sandegren: Ragundatraktens postglaciala utvecklingshistoria enligt den subfossila florans vittnesbörd, constituting Part III of "Ragundasjön en geomorfologisk, geokronologisk, växtgeografisk undersökning," by H. W: son Ahlmann, C. C: zon Caldenius, and Ragnar Sandegren, *Sveriges Geol. Undersökning*, Ser. Ca, No. 12, 1924, Stockholm; reference on p. 43. Reviewed in this number of the *Geographical Review*.

[11] Ernst Antevs: The Big Trees as a Climatic Measure, in *Carnegie Instn. Publ. No. 352* (in press). Also *Year Book Carnegie Instn. of Washington No. 22*, Washington, D. C., 1924, pp. 299–301.

recorded in the sequoia curve and is probably also marked in the clay deposits of Sweden, where the stress expressed itself in unusually cold winters, cold and rainy summers, and violent storms. If this proves to be the case, and if other marked fluctuations in the tree curves are found in the clay curve, a connection may be made with a high degree of probability, and the length of post-glacial time in Sweden exactly determined.

De Geer's Post-Glacial Chronology

When Lidén encountered difficulties in his studies in the valley of the Ångermanälven because of the constant outward shifting of the river mouth, De Geer conceived the idea that it might be easier to sum up the post-glacial varves deposited in a lake where all were accumulated in unbroken series from bottom to top.[12] Thus, in the fall of 1909 he studied the deposits of the ancient Lake Ragunda (63° N.) situated between Bispgården and Lake Gesunden in the valley of the Indalsälven River. Lake Ragunda had been dammed by an esker barrier across the ancient river channel and had its outlet over a rock ledge, but in 1796 it was catastrophically drained after the dam had been partly dug through. The lake deposits thereafter became deeply trenched by the stream. In the exposed sediments at Vidbäcken De Geer studied a section. He measured the varves in part of the profile, counted them in another part, and estimated them in the remaining uppermost part. He measured in all about 700 post-glacial varves and figured that the whole post-glacial sequence of annual layers amounted to about 7000. However, continued studies of Lake Ragunda carried out since 1911 by De Geer's pupils, Ahlmann, Caldenius, and Sandegren show that the deposits of the lake contain in all only about 3700 post-glacial varves and that the basin had become practically filled with sediments several thousand years ago.[13] Recently, as mentioned, De Geer using Lidén's investigations has made a new estimate of length of the post-glacial time.

Correlations

The Swedish late-Quaternary clay geochronologies are generally considered to be incompatible with all other late-Quaternary chronologies. It is true that they have considerably reduced the earlier estimates of the time elapsed since the uncovering of Sweden began,[14] but for the rest the view seems to be based upon hasty correlations. According to the best

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[12] See footnote 5.

[13] Hans W: son Ahlmann, Carl C: zon Caldenius, and Ragnar Sandegren: The Qu ternary History of the Ragunda Region, Jämtland, *Geol. Fören. Förhandl.*, Vol. 34, 1912, pp. 343–364.

Idem: Ragundasjön en geomorfologisk, geokronologisk, växtgeografisk undersökning, *Sveriges Geol. Undersökning*, Ser. Ca, No. 12, 1924.

[14] T. C. Chamberlin's statement (The Age of the Earth from the Geological Viewpoint, *Proc. Amer. Philos. Soc.*, Vol. 61, 1922, pp. 247–271; reference on p. 251) that De Geer's method tends to make the retreatal stage of the last glacial epoch *three times* as long as it was made by the most representative of the old estimates must be an error. Chamberlin must mean *one-third* as long.

American time estimates, viz. that by Taylor[15] based upon the recession of Niagara Falls and that by Coleman[16] founded upon the formation of the Iroquois beach, the abrasion of Scarborough Heights, the building of Toronto Island, etc., the uncovering of the Niagara Falls region from the ice took place some 20,000 to 30,000 or possibly 35,000 years ago and the release of Toronto 24,000 to 27,000 years ago, or both events in round figures 25,000 years ago.[17] About 10,000 to 11,000 years ago, under the assumption that the cutting of the whole Niagara gorge represents 25,000 years, the stage in the history of Lakes Superior, Michigan, and Huron called the Nipissing Great Lakes came into existence. It began as the ice edge retired from the Mattawa Valley and started to wane in earnest after having halted, readvanced, and receded slowly during the Kirkfield and Port Huron stages of Lake Algonquin and the cutting of the corresponding Old Narrow Gorge and Lower Great Gorge by the Niagara River, that is to say for between 10,000 and 15,000 years. This zone of retardation probably corresponds to a similar zone of stagnancy in the Danish Islands and southwestern Scania[18] which was followed by rapid ice retreat some 13,000 to 13,500 years ago according to clay-geochronological determinations. According to this correlation, which is the only one that with our present knowledge of the waning of the last ice sheets comes into consideration, the Swedish and the American time estimates differ but little.

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[15] F. B. Taylor and E. M. Kindle: Niagara Folio, *U. S. Geol. Survey Geologic Atlas, Folio No. 190*, 1913. Cf. J. W. W. Spencer: The Falls of Niagara, *Geol. Survey of Canada Publ. No. 970*, Ottawa, 1907.

[16] A. P. Coleman: An Estimate of Post-Glacial and Inter-Glacial Time in North America, *Compte Rendu Congrès Géol. Internatl. XII, Canada, 1913*, Ottawa, 1914, pp. 435–449; reference on p. 442.

[17] A. P. Coleman: Glacial and Post-Glacial Lakes in Ontario, *Univ. of Toronto Studies, Biol. Ser. No. 21*, 1922; reference on p. 71.

[18] Ernst Antevs: The Retreat of the Last Ice Sheet in Eastern Canada, *Geol. Survey of Canada Memoir* (in press).

COMMERCIAL GEOGRAPHY AS A SCIENCE

REFLECTIONS ON SOME RECENT BOOKS*

By Isaiah Bowman

The recent receipt of a number of books on related themes within the broad field of commerce naturally raises the general question. What is commercial geography? As a discipline it has swiftly displaced much of the physical geography of an earlier period. Its practical objectives have appealed to schools of commerce and to junior students searching for a means of making a living rather than a means of discovery or explanation. Its scientific value was much less seriously argued at first. Now we are in a new stage. Huntington and Williams open the preface to "Business Geography" with the dictum, "Modern geography has become a definite science." They continue: "Its principles are so well defined that a knowledge of the physical conditions under which a race has lived and now lives gives a reasonably reliable indication as to the capacity, activity, occupations, and business relations of that race." The style of the book carries one well along the road toward conviction that the authors have made out a case—but conviction does not quite arrive.

There is real scientific spirit in the introductory statement of Jones and Whittlesey: "Among the conditions which have bearing on economic activities . . . none is more fundamental than the natural environment, none changes so little from generation to generation, and none varies more from region to region." " . . . man may make and does make a choice as to

*R. H. Whitbeck and V. C. Finch: Economic Geography. 1st edit. x and 558 pp.; maps, diagrs., ills., index. McGraw-Hill Book Co., Inc., New York and London, 1924. 9½ x 6 inches.

Ellsworth Huntington and F. E. Williams: Business Geography. x and 482 pp.; maps, diagrs., ills. index. John Wiley & Sons, Inc., New York; Chapman & Hall, Ltd., London, 1922. $2.75. 9 x 6 inches.

Ellsworth Huntington and S. W. Cushing: Modern Business Geography. viii and 352 pp. maps, diagrs., ills., bibliogr., index. World Book Co., Yonkers, N. Y. 1925. 9½ x 6½ inches.

W. D. Jones and D. S. Whittlesey: An Introduction to Economic Geography. Vol. 1 :The Natural Environment and Its Bearing on Economic Activities. Preprint No. 1, xiii and 3–38, 103–188 pp.; Preprint No. 2, viii and 39–68, 193–275 pp.; Preprint No. 3, vii and 69–91, 277–362 pp.; maps, diagrs., ills. University of Chicago, 1924. 9 x 6 inches.

W. D. Jones and D. S. Whittlesey: Suggestions to Teachers Using "An Introduction to Economic Geography." 9 pp. University of Chicago, 1924. 9 x 6 inches.

G. G. Chisholm: Handbook of Commercial Geography. New edit. xv and 824 pp.; maps, diagrs., index. Longmans, Green & Co., London, New York, Toronto, Bombay, Calcutta, and Madras, 1922. $7.50. 8½ x 6 inches.

G. G. Chisholm and J. H. Birrell: A Smaller Commercial Geography. New edit. xiv and 302 pp.; index. Longmans, Green & Co., London, New York, Toronto, Bombay, Calcutta, and Madras, 1923. 5s. 7½ x 5 inches.

E. G. R. Taylor: The Business Man's Geography. A Compendium of General and Post-War Conditions in Respect of Overseas Produce and Overseas Markets. 2nd edit. xvi and 496 pp.; maps, index. George Philip & Son, Ltd., London; Philip, Son & Nephew, Ltd., Liverpool, 1924,. 9 x 6 inches.

M. I. Newbigin: Commercial Geography. 256 pp.; index. (Home University Library). Henry Holt & Co., New York; Williams & Norgate, London, 1924. $1.00. 7 x 4½ inches.

Clive Day: A History of Commerce. Revised and enlarged. x and 676 pp.; maps, bibliogrs., index. Longmans, Green & Co., New York, London, Toronto, Bombay, Calcutta, and Madras, 1923. $2.50. 8 x 5½ inches.

A. L. Bishop: Outlines of American Foreign Commerce. vii and 321 pp.; bibliogr., index. Ginn & Co. Boston, New York, Chicago, London, Atlanta, Dallas, Columbus. San Francisco, 1923. $3.00. 8 x 5½ inches.

how his economic life is ordered." "The peculiar contribution of economic geography is an understanding of the relation between natural environment and economic life." Whitbeck and Finch have this to say: "Economic geography . . . endeavors to show the influences exerted by topography, climate, geographical position, and by soil and other natural resources upon the various types of activity by means of which man gains his living." They warn the reader that this is not all of commerce or business; and in the actual text, chapter by chapter, "geographical influence" is often lost in the mists of detail. We do not point this out by way of criticism; it is only the fact that we wish to note at this point. For "geographical influence" as a central all-embracing principle of geography is on the defensive. The number and variety of authentic illustrations of geographic factors in operation are increasing, one is tempted to say, almost in geometrical ratio, but so too is an appreciation of the truth that the *problem* is the thing, not this and that unrelated influence. The subject is still overloaded with absurd or trivial examples of alleged influence such as Congo dwarfs adapted in size to hunting in dense forest and jungle, or railroad tunnels through ridges instead of asking engines to follow the example of goats and mules. E. V. Robinson, as early as 1910, put the case fairly:

> . . . Those who have sought to rationalize the subject have as a rule proceeded on the assumption that everything must be explained, if it is to be explained at all, in terms of physical environment. The attempt, however, to explain the immensely complex distribution of industries by one set formula—the influence of environment—results in innumerable forced, artificial explanations which do not really explain. In the end, after the geographical factor has thus been seriously overworked, the usual upshot of the matter is a relapse into the old plan of piling fact upon fact, figure upon figure, without any serious attempt at explanation.[1]

Chisholm is content to give a list of subjects of which commercial geography treats, and he bases his work broadly upon commerce rather than upon the principle of "geographic control." This view of the subject is strikingly illustrated in the list of "subjects for research" given in his "Handbook" (pp. 22–23). He treats commerce as if it were a problem in and by itself, and he is not concerned with the boundaries of geography in relation thereto. For those who study commercial geography not for its philosophy but as a practical guide to business his method is certainly commendable; for those who plan to become professional geographers the superabundant facts appear to choke the philosophy. The philosophy is there—no doubt of that. It is sandwiched in everywhere, and very compact and very sound it appears. His "Goal of Commerce," the Herbertson Memorial Lecture for 1924,[2] is one of the ablest statements published in the field of commercial or economic geography. Chisholm is a scholar always. Evident also is the fact that his scholarship is in his head and not in his notes merely. His handbook, in its ninth edition after thirty-three years, is the mother of a widely scattered progeny.

[1] E. V. Robinson: Commercial Geography, Chicago and New York, 1910, p. vi.

[2] *Geogr. Teacher*, No. 69, Vol. 12, 1924, Summer, pp. 333-342.

Ubique, everywhere, appears to be the symbol of geography, taken literally; and thereto is added *everything*. Professor Davis insists on the question, Is it geographical? And Kipling writes, almost as if he had heard an echo of the annual discussion of Professor Davis' question at one of the December meetings of the Association of American Geographers:

There's nothin' under 'eaven or 'ell Ubique doesn't mean.

To the question, Is it geographical? we may add another, Is it science? Perhaps a brief excursion is justifiable at this point. The search for truth is admittedly one of the greatest of the spiritual purposes of mankind. Yet "What is truth?" is no less debated now, with evolution a matter to be decided by legislative assemblies, than it was nineteen centuries ago. The aspiration to find out the truth of a thing may have nothing whatever to do with the result; but the spirit of investigation is a recognizable quality no matter what differences arise respecting the meaning of a thing when found. There is no such thing as a complete inventory of truth. There is no guidebook for this kind of journey. Peoples bred in different environments and inheriting different cultures or philosophies of life may look upon the world in quite different ways and have divergent standards of truth and purpose. Even in the United States there are strong and persistent regional differences respecting educational objectives in science no less than in the field of political policies. What a subject should be in content or style of treatment is not a matter of final and definite decision by a court of reference, especially if that subject deal with man, his ways and works.

We should probably all agree that one of the objectives of commercial geography is to aid in helping man measurably to command the earth instead of being commanded by her. And by "being commanded" we mean influenced and not necessarily controlled. We should like to have the subject become an agency of power and thus help man to extend his dominion over nature. If "man is the measure of his own universe" then commercial geography, of all branches of the science, ought to afford him direct and immediate help. It ought to enable him to extend his occupation of the land out into the difficult pioneer belts where the margin of safety is small; "to interpret the earth in terms of its usefulness to humanity," as J. Russell Smith sets the problem in "Industrial and Commercial Geography." It ought to tell him where he is inefficient and how better to use and possess this earth of his. For example, shall a crop like alfalfa be cut and cured green by artificial means or dried wastefully by sun and wind? If it is possible by the former means to increase the food supply three or four times, shall agriculture struggle along as now or shall it to a large degree adopt new means and defeat some of the enslaving forces of nature? Just to know the facts of his world is not enough. Biologically man is crowding the planet. Is his research in commercial geography also dealing with the fringe of facts? Is it seeking new truth?

The Measure of a Science

To be a science commercial geography ought by definition to fulfill three conditions: it should (1) have its facts arranged in a systematic order; (2) rationally explain present conditions in accordance with established "laws"; (3) predict the future course of development or lead the way to the discovery of new laws. These it should do not in any absolute or infallible sense but with some degree of accuracy. The tests applied by one person in a given solution must be capable of verification at other places and by other men under standard conditions, just as a physicist or a physiologist lays down the governing conditions of his experiment and confidently invites verification of a truth or law which he claims to have discovered. The terms of discussion are in the main specific, not general, and every step in a proof must rest upon facts and a logical progression of argument.

If we apply these tests to commercial geography the subject appears to be far from being a science; and there are, moreover, but few indications of its so becoming. There is, however, one commendable example of its progress in this direction which is at once so striking and convincing in character that it deserves special recognition. If a substantial part of commercial geography rested upon problems solved with this degree of exactness its status as a science would be beyond question. The example in point is embodied in a paper by J. F. Unstead entitled "The Climatic Limits of Wheat Cultivation, with Special Reference to North America."[3] The main argument runs as follows. The existing limits of wheat cultivation are rarely set by physical controls but rather by economic factors such as facilities for transport and the supply of labor. Furthermore, the ultimate limits cannot now be estimated in a final manner, for man himself may alter the range of cultivation by increasing his knowledge of seed, soil, and agricultural operations. These things eliminated, Unstead proceeds to the setting of limits under existing conditions and draws his limiting line upon a map. His argument of 20,000 words or more cannot be repeated here, but among his conclusions are the following (the italics being ours):

> . . . *Wheat cultivation is possible* at stations where the degrees of accumulated temperature, which is experienced between the dates when the mean temperature curve rises above 5° C. in spring and descends to 10° C. in autumn, amount to the number indicated by the straight line in Fig. 3 as that required under the conditions of mean temperature and duration of light during the same period at the respective stations.[4]

He then goes on to say significantly:

> This conclusion may be *tested* by . . .

Further on he adds:

> . . . With the adoption of suitable methods of cultivation, including summer-fallowing and the use of drought-resistant varieties, wheat cultivation *will be possible* over the whole of the semi-arid region of southern Alberta and Saskatchewan.[5]

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[3] *Geogr. Journ.*, Vol. 39, 1912, pp. 347–366 and 421–446.
[4] *Loc. cit.*, p. 359.
[5] *Ibid.*, p. 435.

Put beside the commercial geographies a text like Davis' "Physical Geography," and the difference between a book loaded with inappropriate descriptive detail and a book worked out step by step as a science is all too apparent. Happily, the present may be a passing stage in the development of commercial geography. It may be that the rapid organization of the data of the subject will be followed shortly by a new organization of principles or laws. The problem seems to be to get past the stage of propaganda. Each author writes as if he had to make out a case for his subject as science or for a given detail as geographical. Even the boundaries of the subject (according to some) seem to be in perpetual need of defense, like all pioneer enterprises on the border of the wilderness. This tempts an author to protest too much and too often. By contrast, a physicist goes directly to his point, neither trying to prove that it is science nor seeming to care whether or not you call it physics. To him, as it should be to us, the problem is the thing, and the subject of boundaries is academic.

In *Nature* for January 17, 1925, there is a thoughtful review of Brunhes' "Human Geography." It ends on a note of the deepest importance in the consideration of any part of geography as a science.

> Whither does all this lead? Apparently to the notion that geography is not a science, not an ordered body of knowledge, which is independent of the personality of the investigator, not a set of conclusions which must be universally valid, not a statement of generalisations valid for all time or for every place, but primarily and fundamentally a discipline, an outlook on man's life on the earth, which gives to the thinker that unique geographic sense so invaluable for the law-maker, the captain of industry, and the merchant prince, so useful a corrective in all matters which pertain to the conduct of human affairs on the large scale.
>
> Whatever view may be taken, it must be confessed that the facts of geography are stubborn; they cannot be melted in the mental furnace and run into set moulds; they frequently misfit the theories: but the spirit of geography is of unique value. No other human study permeates so many of the sciences: no other study is so necessary to the equipment of the educated man.[6]

Perhaps enough has been said to show that there are two distinct groups of data in commercial geography: (1) a group of facts capable of rather rigid scientific treatment; (2) a group of facts so related to the changing spirit of man and his inventions that less importance should be attached to the mode of treatment than to the geographical point of view. The indulgence of the reader is asked while we gently insist on the point that commercial geography cannot be treated *throughout* like mechanics or light or chemical elements.

The Potato: A Homely Example

Granted all this, geography still remains in a state of thralldom. Tradition hems it about. It is in science what the division Vermes long was in biology—a wastebasket. When you didn't know what to call a thing, you called it a worm! It is a grave question in education as in research how to

[6] *Nature*, No. 2881, Vol. 115, 1925, Jan. 17, p. 76.

take off the overload of irrelevant detail of an encyclopedic nature. Take potatoes as a homely example. One author says: "The states of Minnesota, New York, Michigan, Wisconsin, Pennsylvania, and Maine are the greatest potato producers. Certain parts of those states, where the climate is cool and moist and the soil sandy, are especially adapted to potatoes . . . Aroostook County in the northern part of Maine is by far the best potato region in the whole United States." Is it due to climate or soil? If the author knew how potato culture is organized in Maine he would have said much on that score and less about climate and soil. In Aroostook County potato culture is almost a disease!

The fact is that in many parts of the United States potatoes are a crop of the first importance where the soil is not sandy. A clay loam with an exceptional admixture of humus is also "especially adapted to potatoes." Why do potatoes from sandy soils form an important basis of commerce? The author does not say. The fact is also that a cool climate is not essential. The potato originated in the high and distinctly dry regions of the Central Andes and has quite remarkable powers of adaptation to climate, being cultivated in the tropics as well as in high latitudes, "even beyond the polar limit of barley." Whitbeck and Finch (pp. 54-56) get at the heart of the problem in a few words though one could wish a better statement of soil requirements or importance.

Taking the texts one after another, and the staples one by one, and the same criticisms may be made in the majority of cases that have been made in the case of potatoes. The most important exception among all the authors is Chisholm. No one else has so controlled his discussion with facts. Being a superlatively modest scholar he says little in the way of criticism of the carelessness of other authors in his field. But he must have lots of fun reading them! Is there a geography of potatoes that is capable of scientific treatment? O. E. Baker could write about it and explain things and predict. Why does a "sandy soil" get all this favoritism? Will the top soil of a cool, sandy beach in "a moist climate" grow an abundant crop of potatoes? There's a deal of science here that the texts do not take into account though the authors make room for much interesting though irrelevant detail.

Not reasoned explanation but easy appeal to soil, climate, and relief is the rule. "The limiting factor in the agricultural development of Argentina is rainfall." Such a statement raises more questions than it answers. Is it good science to leave it as the introductory sentence of a regional description? It reminds one of a recent contributor to *Science* who stated that a certain region had an "Arctic climate." How would one define that kind of a climate? How would one use the alleged fact in an ordered argument? *What does it mean?* More naive is the following: "If a farmer cannot sell his potatoes or milk, he at least has something on which he and his family can live. But if the manufacturer of screws cannot sell his product at a price sufficient to pay for the cost of manufacture, he and his employees

have no means of getting a living." This is not like art a thing that must be felt to be understood; it can be thought out. The leading hardware company of St. Louis knows better. Take the simplest of three or four main aspects of such a problem. If it be replied that to "getting a living" is added "in the long run" (understood), then how will the farmer clothe his family in the long run? How does *any* manufacturer determine the scale of his production? Does he live by salesmanship alone? The fact is that his decision rests in part on something very definite.

What is authentic and what is apocryphal, only the ripening influence of time will show. Commercial geography, like geography in general, as a subject, has a cultural and also a practical value to living men that far transcends its purely scientific content. But when we *claim* a definite scientific character for the subject as now developed, are we not claiming too much? The science in it is still far too feeble and juvenile, the purely descriptive portions too encyclopedic and irrelevant. The books are full of the data of commerce; there is needed a Davis or a Vidal la Blache to give the data scientific organization.

Whitbeck and Finch's "Economic Geography"

Half of this book is devoted to the United States and Canada, and the remaining half takes up the several states of principal commercial importance in the world. The leading American text in which economic theory and the problems of transportation are interwoven with the facts of physical environment has been Smith's "Industrial and Commercial Geography" first published in 1913. Whitbeck and Finch now share the position. Admirable is their close organization of the facts of commerce and the brief and sound explanations of the tendencies of commerce in a given physical framework. The argument runs less securely in foreign fields. In the case of The Netherlands, for example, we discover in the last paragraph that "the Dutch are inherently a commercial and seafaring people, as centuries of their history have shown . . "; but the development of the idea, that is, the effect of seafaring life and its full meaning in The Netherlands today, are not brought out in the remaining twelve lines of the paragraph. It would seem as if this theme should be the dominant one in the section and overshadow in intensity of treatment the purely descriptive portions. The text is a substantial contribution to the literature of commercial geography, and it deserves consideration among the first class of books in its field.

Huntington and Williams' "Business Geography" and Huntington and Cushing's "Modern Business Geography"

In both of these texts, the one advanced, the other elementary—there are two features of which special mention should be made, the attractive style in which they are written and the attention given, especially in the

elementary book, to the exercises and problems that follow each chapter. The weakness of the books lies in the field in which Whitbeck and Finch are strong: there is no proper basis of economic theory, and the explanations are far from being secure. The problems of today are cleverly pointed out, and the point of view is one which will stimulate the student to fresh and original investigation. So far as the writer of this article is aware, no book now in the market save Jones and Whittlesey (see below), gives so much attention to the solving of problems by the student himself. An important pedagogical principle is illustrated by the two books: in the case of the advanced book the technical typographical treatment is uninviting, whereas in the case of "Modern Business Geography" every device of typographical display and of illustration has been worked out in a most attractive manner.

Jones and Whittlesey's "Introduction to Economic Geography"

From the standpoint of practical work on the part of the student these volumes deserve a leading place. The scheme of organization is novel. Each of the three books consists of three parts. Part I deals with exercises. Part II deals with textual materials built up partly by contributions from the authors themselves but in greater part by exceedingly well selected quotations from geographical literature so cleverly arranged that there is a progression and unity of purpose which other authors achieve by a text in which all of the material is newly reworked. Part III consists of illustrations, diagrams, graphs, photographs, maps, charts, and the like. The questions in Part I are arranged in systematic order as if the whole were a text of the ordinary kind. The value of the books lies in the ingenuity and skill and particularly in the sound judgment which have been expended in the framing and arrangement of the questions. No commonplace or haphazard scheme of treatment has been adopted, but rather a scientific use of the method of inquiry. Next to a first-class text in which all the material is thoroughly reworked and given unity of scientific treatment and a rigidly close organization of both principles and facts is the method adopted by these authors, who depend upon original descriptions, photographs, and maps for the integrity of the successive lessons. Having said this much in praise of the excellent organization of the material perhaps a word of criticism may be permitted and it can be put in the form of a conundrum: Q. When is a map not a map? A. When it has neither scale nor coördinates.

Chisholm's "Handbook of Commercial Geography"

We have already commented on the number of excellent features in Chisholm's handbook. It only remains to say that the author has spared neither expense nor effort to bring his text up to date. Published in 1922, its maps do not always display the existing boundaries. The present eastern boundary of Greece does not appear on the general map of Europe, and the Smyrna district of late Greek occupation is no longer valid. These

are mentioned only to illustrate the difficulties which any text published since the war has had to face on account of changing boundaries, a difficulty of the history texts as well as those in geography. In the organization of the material under each political unit the author has included the outstanding facts of political condition, new grouping of resources, and the shifting of emphasis to accord with the economic conditions set up in the new or greatly modified states of Central Europe. The reference value of the work is greatly enhanced by the inclusion in the appendix of a large variety of statistical material relating to trade and by a list of alternative geographical names, of special value at this time in view of the changes brought about by nationalistic sentiment.

Chisholm and Birrell's "Smaller Commercial Geography"

But little need be said of the smaller edition of Chisholm's work prepared by Mr. Birrell. The smaller book gives no space to what may be called the philosophy of the subject; it consists almost entirely of statements of fact. Commercial geography is defined as consisting of certain "subjects." The facts given are those relating to commerce alone and are arranged according to regional categories save for a few introductory explanations. The method seems to be non-applicable to American conditions of education, and the matter itself seems to have been prepared for the purpose of special examinations; but, of course, this is conjecture.

Taylor's "Business Man's Geography"

The object of this book seems to be purely practical, that is to make it a work of reference merely rather than a work of science. Its title is its whole explanation. The matter is arranged in alphabetical order throughout: the first page treats of Abyssinia, and the last topic on the final page is Zululand. The treatment of facts under the several headings is purely informational or encyclopedic. The maps are bold and coarsely drawn for reproduction on rough paper; and, though their appearance is in general not pleasing, a number of them are cleverly conceived. Particular mention should be made of the excellence of Figure 52, showing the manufactures and communications of Czechoslovakia (which should really read Bohemia in this instance).

Newbigin's "Commercial Geography"

For its length Miss Newbigin's book contains far more discussion of principles and causes than any of the other books of the series. Details are subordinated to their proper place as illustrations of a principle or a relationship, and broad knowledge and excellent judgment are among the elements that go to constitute a book exhibiting real craftsmanship. Perhaps these good qualities have been achieved because the book falls in a special series

of elementary books on substantial themes worked out for the mature reader rather than for formal classroom purposes. Whatever the reason, the result is unquestionably a book of high grade. In comparison with the other texts and for educational purposes the book suffers because of the lack of any illustrations whatever, either in the way of maps or photographs, since these fall outside the scope of the series in which the book has a place.

Day's "History of Commerce"

We have thrown into the references at the beginning of this article two books that are not commercial geography by intention, and the preliminary discussion of commercial geography as a science is therefore to be understood as having no application to these texts. It is rather for the purpose of bringing them to the attention of American geographers that they are included here. Professor Day's book has been revised several times since its original publication in 1907, and the latest revision has brought the "History of Commerce" down through the war years and the "two or three years of peace immediately following." The text has been reworked several times, and it now exhibits a high degree of organization. It is of particular value to students of commerce because the author, not a geographer, has taken into account every sort of factor that he deems important in the development of commerce, whether it relates to public finance, currency, foreign exchange, or the general trends and conditions of international trade. The chapters on exploration and discovery, roads and railroads, and navigation convey an unusual amount of geographical information. Were some of the data of this book and also its explanations of the development of present conditions to be combined with the geographical philosophy and treatment of Whitbeck and Finch, or Chisholm, or Newbigin, it would seem as if the result would be far ahead of even the best of the commercial geographies now in the field.

Bishop's "Outlines of American Foreign Commerce"

There is here a steady flow of statements of fact, and the arrangement is logical throughout. The book proceeds from natural resources and industries to the export and import trade of the country and related problems of insurance, financing, and promotion. The usefulness of the book as a work of reference to commercial geographers is worth emphasizing, though there seems to be little real attention to the explanations of things but rather a statement of the order of events despite the first sentence of the preface, which states that the intention is to develop the subject "in the light of the fundamental principles upon which trade is based." Immediate or proximate "causes" are discussed rather than principles.

AMERICAN GEOGRAPHICAL SOCIETY

Meetings of January and February. The annual meeting of the American Geographical Society was held on January 20, at the Engineering Societies' Building, 29 West Thirty-ninth Street. After the reading of the annual reports and the election of officers for 1925 the Society was addressed by Mr. Merian C. Cooper on "The Migrations of the Bakhtiari." Both films and still pictures were of extraordinary geographical interest. They depicted the life of a nomadic people during their eastward migration from the plains of Arabistan, north of the Persian Gulf, to the Plateau of Ispahan in Western Persia, a journey of forty-six days which involves the crossing of the deep Karun River and the rugged Bakhtiari Mountains.

At the regular monthly meeting of February 24 an illustrated lecture of unusual scientific interest was given by Dr. Philip S. Smith of the U. S. Geological Survey, on "Exploring in Northern Alaska." An article on this subject appears in this number of the *Review*. The field of Dr. Smith's latest work includes the Naval Petroleum Reserve, parts of which have not been explored hitherto.

Elections to Fellowship. At the January meeting of the Society, President Greenough presiding, and the February meeting, President Finley presiding, there were presented with the approval of the Council the names of 229 candidates who were duly elected as Fellows.

Resolution in Honor of President Greenough. At the February meeting of the Council the following resolution was adopted in view of Mr. Greenough's election as Honorary President of the Society. It was read to the Fellows of the Society at the regular monthly meeting on February 24.

RESOLVED that the following minute be entered upon the record:

Mr. Greenough became a Fellow of the Society in 1883 and a member of the Council in January, 1900. Besides serving on various committees of the Society he was Chairman of the Council from March, 1906, to February, 1907, and February, 1913, to February, 1921; and Vice-President from January, 1908, to January, 1916. In 1916 he was elected President of the Society and in that capacity has served for nine years. In that period there took place many changes in the administration of the Society's professional work. It was he who first proposed the appointment of a professional geographer as Director of the Society. Through an extension of the functions of the several committees, such as the Publication Committee, the Committee on Exploration and Research, the Committee on Medal Awards, and a number of other special committees all of which were appointed at his suggestion, the Council was brought into much more active relation to the work of the several departments than at any previous time. The result of these steps has been greatly to extend the area of general interest in the work of the Society and to bring about a great advance particularly in its publications.

He has presided at the regular meetings of the Society with a fidelity unsurpassed in its history and, like Judge Daly, has left a permanent impression upon the membership of the Society by reason of his unfailing attention to its business. In a period of fourteen years he was absent but once from his place as Chairman at the regular monthly meetings of the Council and Fellows.

In recognition of his service to the Society and as a mark of respect, his colleagues on the Council have unanimously adopted this resolution and directed that the same be read at the next regular monthly meeting of the Council and Fellows.

Annual Reports of the Society. At the annual meeting of the American Geographical Society, held on January 21 at the Engineering Societies' Building, 29 West Thirty-ninth Street, the annual reports of the Council, of the Treasurer, and of the Special Committee were read as follows:

Report of the Council

New York, January 15, 1925

To the Fellows of the Society:

In our review of the Society's activities for 1925 a place of importance must needs be given to the *Geographical Review*, the quarterly journal of the Society. Each number contains a quantity of scholarly material as great as that found in a book of substantial size, and no less impressive than the amount of it is its extraordinary variety and interest. The thirty-eight principal articles in addition to the seventy-eight notes and sixty-eight reviews published in 1924 deal with leading problems in every branch of geographical science: they are not casual or temporary in nature; we aim to make them permanent contributions to knowledge. The maps which illustrate the several articles are drawn so far as possible from new and original sources and, drawn with high professional skill and accuracy, they have contributed to make the *Geographical Review* one of the leading scientific journals in the world today.

Though the Society has concentrated its research work to a large degree in the field of Hispanic American maps, it has by no means confined itself to that field. It has also supported in one form or another studies in the soils and vegetation of Africa, in historical geography, colonization, population distributions in many lands, in political geography in the problem areas of the world, as well as substantial enterprises in the United States. The Society's point of view with reference to specific projects of publication, field work, and research is that it should undertake to do those things which contribute to the general good of geographical science and professional geographers of every class and which the individual geographer could not do, working as he must, single-handed, and with very limited funds. The Millionth Map of Hispanic America has made excellent progress. The compilation and drawing of new sheets go forward steadily, and the coöperation of various societies, bureaus, and governments in the southern countries has been secured. The governments of Panama, Ecuador, Bolivia, Peru, Chile, and Salvador have taken an especially active part during 1924 in advancing the purposes of the program. Related publications, such as the map catalogue in process of compilation, and the regional and population studies referred to in earlier reports, are in a state of healthy progress.

The books and maps published by the Society during the past year include the following:

1. The Geographical Conceptions of Columbus: A Critical Consideration of Four Problems. By George E. Nunn.

(A new and original statement of problems to be solved, and established conclusions to be reconsidered.)

2. Geographical Lore of the Time of the Crusades. By J. K. Wright.

(A study in the history of geography illustrating the origins and condition of geographical knowledge and tradition in Western Europe.)

3. Desert Trails of Atacama. By Isaiah Bowman.

(A study of desert and high mountain and plateau settlements in the Atacama region of northern Chile and northwestern Argentina.)

4. Geography in France. By Emmanuel de Martonne.

(A history of the development and present status of geography in France by one of its leading exponents.)

5. Early Topographical Maps. By J. K. Wright.

(Their Geographical and Historical Value as Illustrated by the Maps of the Harrison Collection of the American Geographical Society.)

6. Map of Hispanic America, 1:1,000,000 (15.78 to 1 inch). Sheets South C–19, Acre, and North 9–12, Baja California-Sur.

7. Map of the Mohammedan World.

(Accompanies "The Mohammedan World," by Isaiah Bowman, *Geogr. Rev.*, Vol. 14, 1924, pp. 62–74. Shows population distribution, rainfall, interior basin drainage, railways, etc.)

8. Map of San Juancito Mountains, Honduras. By Joseph H. Sinclair. Scale 1:150,000.

9. Triangulation of an Area in Southern Honduras. By Joseph H. Sinclair. Scale 1:1,250,000.

(Accompany "Notes on the Mapping of an Area in Southern Honduras," by Joseph H. Sinclair, *Geogr. Rev.*, Vol. 14, 1924, pp. 275–281.)

10. Province of Esmeraldas, Northwestern Ecuador. Scale 1:1,280,000.

(Accompanies "Geographical Notes on Esmeraldas, Northwestern Ecuador," by Carlos M. Larrea, *Geogr. Rev.*, Vol. 14, 1924, pp. 373–387.)

Among the publication projects for 1925 there are two that are especially noteworthy:

Bibliographie Géographique

By a coöperative arrangement with the *Association de Géographes Français* the Society participates in the preparation of material and the publication of this scholarly bibliography in order to make a contribution to the facilities for research in the United States. The first number to contain material contributed by the Society is Volume 33, dealing with publications for 1923. It is now in process of distribution by the Society.

Arabian Geography and History

Through the interest and generosity of Charles R. Crane, Esq., the Society is enabled to edit, publish, and distribute the results of thirty years' study of Arabian geography and history on the part of Professor Musil, of which fourteen years were spent in the field. The work will be produced in six volumes and will be illustrated by photographs and diagrams. It will deal with the Northern Hejaz, Arabia Deserta, Palmyrena, the Middle Euphrates, the Northern Neged, and the Manners and Customs of the Rwala Bedouins.

Passing to one of our newer activities, the Society's School of Surveying, it may be noted that the equipment has been completed, the course of study arranged, and instruction has begun. There is now available in this country a place where first-class modern training in field methods especially applicable to geographical science can be provided.

During 1924 the Society awarded three gold medals as follows:

Charles P. Daly Medal to Colonel Claude H. Birdseye, Chief Topographic Engineer of the U. S. Geological Survey. (See *Geogr. Rev.*, Vol. 14, 1924, pp. 465–466.)

Cullum Geographical Medal to Professor Jovan Cvijić of the University of Belgrade. (See *Geogr. Rev.*, Vol. 14, 1924, p. 466, and Vol. 15, 1925, pp. 131.)

David Livingstone Centenary Medal to Commander Frank Wild of the expeditions of Scott, Mawson, and Shackleton. (See *Geogr. Rev.*, Vol. 14, 1924, p. 466.)

The Society has also elected the following to honorary Corresponding Membership: Edwin R. Heath, H. L. Shantz, Paul Le Cointe, Lauge Koch, and Byron Khun de Prorok.

Following precedent the Society has sent representatives to important scientific gatherings and occasions of special geographical interest: Section E, Geography, British Association for the Advancement of Science, Toronto; and the Third Pan-American Scientific Congress, Lima, Peru.

Additions to the library during the year comprise 795 books, 708 pamphlets, 6250 new issues of periodicals, 3015 maps, 73 atlases. The collection now numbers 65,448 volumes of books and pamphlets and 64,085 atlases and maps. Among the conspicuous gifts to the library from generous friends of the Society have been the following:

Crown Collection of Maps, from James B. Ford, Esq.

Cassini Map of France, from the Honorable Francis Burton Harrison.

Collection of Colored Lantern Slides, from Mrs. George Kennan.

The lectures of the Society have been unusually well attended. The speakers have been as follows:

Sir Percy Sykes, "The Heart of Asia and the Roof of the World;" Horace D. Ashton, "A Caravan Journey into the Northern Sahara;" Poultney Bigelow, "The Colonies of Japan;" Colonel Claude H. Birdseye, "Boating in the Grand Canyon;" Count Byron Khun de Prorok, "Ancient Carthage and the Dead Cities of the Sahara;" Dr. Lauge Koch, "Explorations in Northernmost Greenland."

The number of Fellows at the close of the year was 4062, of whom 395 are Life Fellows. In addition there are 12 Honorary and 39 Corresponding Members.

The report of the Treasurer submitted herewith gives a condensed balance sheet and a summary of the income and expenses of the Society.

PHILIP W. HENRY
Chairman

REPORT OF THE TREASURER FOR 1924

Receipts and Expenses

During the year there have been received from annual dues, interest on investments, and sales of publications	$68,396.26
There have been expended for salaries, house expenses, library, meetings, publications, postage, insurance, etc.	78,293.17
Balance charged against Special Deposit Fund	$9,896.91

Condensed Balance Sheet, December 31, 1924

Cash	$10,842.92
Sundry balances and investments	98,976.89
Inventory of publications	7,798.03
	$117,617.84

Capital Account, Balance uninvested	$91.42
Annual dues paid in advance	2,232.33
Special Fund for general purposes	80,562.45
Sundry deposits and reserves	24,443.74
Hispanic-American Research Fund, Balance	10,287.90
	$117,617.84

HENRY PARISH
Treasurer

REPORT OF SPECIAL COMMITTEE

New York, January 15, 1925

The Committee appointed at the meeting of the Council held on December 18, 1924, to nominate officers for the vacancies to occur in the Council in January, 1925, beg to nominate the following named gentlemen for the offices designated and move that the same be approved and presented to the Society for election at its meeting to be held on January 20, 1925:

		Term to expire in
Honorary President	John Greenough	
President	John H. Finley	January, 1926
Vice-President	James B. Ford	January, 1928
Recording Secretary	Hamilton Fish Kean	January, 1928
Treasurer	Henry Parish	January, 1928
Councilors	Philip A. Carroll Archer M. Huntington Charles A. Peabody Frederick C. Walcott	January, 1928

Hamilton Fish Kean
James B. Ford
Archer M. Huntington
Committee

GEOGRAPHICAL RECORD

NORTH AMERICA

Notes on the Arctic Coast of Canada. The existence of copper-bearing deposits on the Arctic coasts and islands of Canada has been known since the eighteenth century when Samuel Hearne made his famous journey northward to the Coppermine River in 1771 in search of a mine reported by the Indians. Since Hearne's time the few travelers who have visited these remote wilds have brought back meager reports of copper ore and of native copper at the mouth of the Coppermine and at various other points—Bathurst Inlet, Boothia Peninsula, Princess Royal Island, and the interior of Victoria Island. Definite information, however, is available only concerning the deposits of the Coppermine River and Bathurst Inlet, the others being known but vaguely through the testimony of Eskimos and other untrained observers. The latest and most detailed data on the Coppermine River and Bathurst Inlet deposits and upon the geology and geography of the neighboring country will be found, together with a geological and topographical map of the coast from Darnley Bay to Bathurst Inlet (1: 633,600), in the *Report of the Canadian Arctic Expedition 1913–18, Southern Party*, Vol. 11: Geology and Geography; Part A, The Geology of the Arctic Coast of Canada, West of the Kent Peninsula, by J. J. O'Neill; Part B, Geographical Notes on the Arctic Coast of Canada, by Kenneth G. Chipman and John R. Cox; Ottawa, 1924.

The Bathurst Inlet deposits lie more than 150 miles east of the mouth of the Coppermine. Mr. O'Neill writes that they "probably form an important reserve of copper ore" but that this reserve "is not sufficiently attractive under present conditions of accessibility, transportation, demand, etc., to warrant the large expense necessary to prove and develop the deposits." Conditions on the Coppermine are more favorable: "It seems highly probable that parts of this district contain workable and even rich deposits." The problem of accessibility is not as serious here, for "the district is easily reached from Great Bear lake, and transportation could be arranged *via* the Mackenzie river valley."

The climate of these regions does not seem to be prohibitive to settlement. At Dolphin and Union Strait, where the members of the expedition wintered, the mean temperature of the months from November to March inclusive in 1914–1915 and in 1915–1916 was $-15°$ F., with minima of $-49°$ and $-45°$. The snowfall is light, not exceeding two feet, and for three or four months during the summer the ground is usually bare. The mean temperature of the summer months, June–September, is over 32° F. Yet, although the winter temperatures are not terrifically low, "a penetrating wind blows almost continuously. We have seen dogs from the interior, accustomed to a dry windless temperature of 60 to 70 degrees below zero, that were miserably cold in zero weather on the coast." Instrumental observations were found to be attended with peculiar difficulties at low temperatures, as a result of the thickening of lubricating oil, the freezing of the observer's fingers, and the freezing and fogging of lenses. Methods for overcoming these difficulties are suggested in Chipman and Cox's paper.

The country along the coast is a bleak tundra, or "barren ground," although willows are found by some of the streams, and "twenty miles up the Coppermine there is plenty of spruce." Driftwood is fairly plentiful from Darnley Bay to Bernard Harbor in Dolphin and Union Strait, but farther east less is to be found. "Except for small quantities from the Coppermine most of the driftwood comes from the Mackenzie" (see E. M. Kindle: Mackenzie River Driftwood, *Geogr. Rev.*, Vol. 11, 1921, pp. 50–53).

At best, conditions of travel in this part of Canada are trying. One of the topographers writes thus: "Northern Canada is cursed, not by its interminable distances, its vast stretches of swamp and muskeg, its isolation, or the bitter cold of its winters; all these one can, with a certain amount of determination triumph over and acquire a fair degree of satisfaction in doing so. It is the astounding atmosphere of mosquitoes that envelops the whole face of the country in summer time that is the real curse."

Colonization in Eastern Canada. Speak of colonization in Canada, and one will naturally think of the Prairie Provinces and British Columbia. There is, however, a distinctly important colonization taking place in the east, especially in Quebec, which parallels the great march westward and northward. The two move-

FIG. 1—Map showing settlement in the Abitibi district of Quebec, 1921. Note the concentration about the railroad. Reproduced on a reduced scale from Figure 17, *Geografiska Annaler*, 1923, p. 287.

ments are compared by Helge Nelson in his book "Canada: Nybyggarlandet" (Stockholm, 1922) and his paper "The Interior Colonization in Canada at the Present Day, and its Natural Conditions" in the *Geografiska Annaler* (Vol. 5, 1923, pp. 244–308).

Colonization in the east is of a patchy character in sympathy with the patchy distribution of areas of good soil on the ancient terrain. The "islands" of cultivation recall those of the similar terrain in Sweden, especially Norrland, and are in contrast with the prairies, where occupation of the land tends to be more uniform. Still the patches are numerous enough for us to speak of advance on a broad northward front from the St. Lawrence towards James Bay. The distinctive nature of the colonization lies in its almost purely internal character. In the whole of Quebec province the number of foreign-born at the 1921 census was only seven per cent. Expansion into the new settlement areas is due in large measure to the high excess of the birth rate over the death rate, about 20 per cent, among the French Canadians. "The most striking feature about Eastern Canada is the influence of racial characteristics in the colonization, seen in the evident energy and success of the pioneering work of the French-Canadian stock, the deliberateness with which patriotism and patriarchal interests are allowed to impress themselves upon this work, and the vitality and contentedness which distinguish the pioneering activities

of the French Canadian." Settlement furthermore owes much to the close relation with the forest. "The French Canadian is, as it were, a born pioneer of cultivation in the forests. He loves them, is a good hunter, and an unrivalled timber-cutter and worker in the woods. He is of sunny disposition, is as playful as a child, is extraordinarily contented, and holds strongly by family and kindred. These are qualities which are able to vanquish a five months' winter with up to 40 degrees of frost. . . . The colonists stick together like clay and straw. There are very few cases where settlers of other nationality and religion have obtained a footing among them."

The chief of the settlement areas are in the down-faulted region about Lake St. John and in the great clay belt. In 1920 the counties of Lac St. Jean and Chicoutimi numbered 65,000 people, practically all in the St. John and Saguenay basins. Colonization is now progressing chiefly to the north and northwest of the lake. It was the lumber industry that first drew settlement here, and the waterfalls and forest resources will continue to make this area industrial as well as agricultural. The great pulp mill of Chicoutimi has created a town of 9000 inhabitants; Jonquière has over 4800. The constantly growing region cannot yet entirely feed itself.

The greatest colonization possibilities on the Laurentian Plateau would appear to be offered by the great clay belt, the total area of which is 175,000 square miles with two-thirds in Ontario. This colonization has been dependent on the railroad. The Canadian Pacific line to Mattawa on the Ottawa River was built in 1883, the branch to Timiskaming in 1887. Colonization has spread out in a semicircle from Lake Timiskaming eastward and northward over a radius of 30 miles. The twelve parishes number 12,000 population and in the more central parts have lost their raw look and taken on the aspect of the well established French settlement.

"A remarkable colonization" is that of the Abitibi area. Before the building of the Transcontinental line in 1912 there was here only a Hudson's Bay Company trading post in addition to the Indian population. In 1913 there were 37 families numbering 329 persons; in 1922 there were 2600 families, numbering 15,085 persons. The boundary between Quebec and Ontario marks a distinct break in colonization. In the latter province true settlement is less advanced, though large-scale lumbering is in operation. Many French Canadians, however, are coming in.

Other settlement areas in Quebec, including the Matapedia district in Gaspé, which is proving attractive to settlers, are described in the Department of the Interior's publication "Natural Resources of Quebec," by M. J. Patton (Ottawa, 1923).

Study of a Glacier in the Canadian Rockies. The recently published maps of the Alberta-British Columbia Boundary Survey (Part I reviewed in *Geogr. Rev.*, Vol. 10, 1920, p. 275) afford an admirable groundwork for the glacialist who wishes to prosecute his researches in the virtually untouched field of the Canadian Rockies. One of the newly-mapped glaciers has been recently visited (1922) and described (*Smithsonian Misc. Colls.*, Vol. 76, 1924, No. 11) by Howard Palmer. This is the Freshfield Glacier 65 miles by trail northwest of Lake Louise. The reservoir of the glacier occupies a broad fan-shaped flat-floored basin in a synclinal fold of the axis of the main range of the Rockies. The surrounding heights exceed 10,000 feet in elevation. The ice discharges through a gorge-like valley to the northeast in a single ice tongue three-fourths of a mile wide and three miles long. The area of ice and *névé* in the system covers 22 square miles.

Observations were made on the daily motion of the glacier (the month was July)—the maximum rate measured was 4.83 inches—and investigations were carried out on the position of the ice tongue. Mr. Palmer reports that this glacier, like all others seen by him in the Canadian Rockies in the last fifteen years, is unquestionably in

a state of retreat. The Freshfield glacier terminates in a thin semicircular concave lip furrowed with typical longitudinal depressions. No precise data as to retreat are available, but from a photograph taken in 1902 the retreat is estimated at 46 feet a year for the twenty years.

Recent Studies of State and County Boundaries in the Western United States. A paper by Ruth L. Higgins in the *Iowa Journal of History and Politics* (Vol. 21, 1923, pp. 397–456) summarizes the history of state and territorial boundaries west of the Mississippi and may well serve as a complementary study to E. M. Douglas' revision of Henry Gannett's monograph "Boundaries, Areas, Geographic Centers, and Altitudes of the United States and the Several States" (constituting *U. S. Geol. Survey Bull. 689*, Washington, D. C., 1923; reviewed in *Geogr. Rev.*, Vol. 14, 1924, pp. 160–161). Whereas the latter gives many topographical details and extensive quotations from passages in the statutes relating directly to the determination and demarcation of the various boundaries, Miss Higgins discusses the boundary changes in their historical setting. She aims to indicate not only the facts of these changes as they have been recorded on the maps but also something of the reasons behind these facts. Gannett's and Douglas' treatment is regional: that of Miss Higgins chronological. Though Miss Higgins' paper falls far short of exhausting a highly fruitful subject and, owing to its lack of maps, is sometimes difficult to follow (unless it be read with constant reference to the admirable cartograms in the Gannett-Douglas volume), it at least gives a clue to the broader influences that have guided the evolution of the primary political divisions of our West: the issues of slavery and free soil, the gold discoveries, the advance of the frontier, local politics, etc. It may be said that stabilization was finally reached with the joining of Oklahoma and Indian Territory and their admission as one state in 1906, for the admission of Arizona and New Mexico as states in 1912 involved no change in boundaries.

Geography, combined with economic and political forces plays perhaps, an even more important part in the development of the internal administrative subdivisions of a state—counties and other units—than it does in the development of states and territories themselves. Though the actual lines of county boundaries are usually determined by considerations of mathematics and astronomy, the size of the counties and the general lay-out of the county pattern at any given date are usually dependent upon conditions of settlement, which in turn are strongly influenced by natural environment. We have an interesting illustration of this in the history of county boundaries in North Dakota recently outlined by Luella J. Hall in the *Collections of the State Historical Society*, Grand Forks, N. Dak., Vol. 5, 1923, pp. 167–250. On more than one occasion in the region which is now North Dakota counties were marked out before the advance of settlement justified their establishment and, in obedience to what might almost be regarded as a natural law, were destined subsequently to disappear. Only when settlement had sufficiently progressed did new counties with new names and new boundaries reappear in the same regions. Thus, in 1862 a tier of four counties was marked out along the eastern edge of the area now North Dakota, but in the following year the act establishing these counties was repealed because "the counties were in Indian territory and consequently were not under the jurisdiction of the territorial laws and courts" (Hall, *loc. cit.*, p. 177). In laws of 1872–1873 no less than twenty-seven counties were demarcated in what is now North Dakota. This was not, however, due to any notable influx of settlers. "In order to facilitate the sale of bonds for the Northern Pacific railroad, counties were laid out and maps were made to give the impression of a well settled and prosperous region, supplying the new road with heavy traffic, and thus assuring good returns on all investments in the bonds of the road. The

capital was named Bismarck to flatter the new Chancellor of united Germany and attract the favorable notice of German capital" (*ibid.*, p. 186). In 1889, when North Dakota and South Dakota were divided and North Dakota became a state, the latter contained fifty-three counties. We may assume, however, that many of these counties in the western part of the state were of a more or less factitious nature, for in 1891 and again in 1895 the total number of the western counties was reduced. "The western half of the state was at this time devoted almost exclusively to ranching, and the unorganized counties were incorporated into organized counties in order that the large herds of cattle and horses might be effectively and adequately taxed" (*ibid.*, p. 224). By 1916, however, when the last new county was organized in North Dakota, the progress of settlement had again led to the justifiable subdivision of the counties that had been enlarged in 1891. At present the state once more, as it happens, comprises fifty-three counties; in the opinion of Miss Hall, the movement of "county organization, always a prominent [one] in a new and rapidly developing state, has almost reached an equilibrium" (*ibid.*, p. 250).

Miss Hall's paper is comparable to the studies of Owen C. Coy on California county boundaries which have already been reviewed in this journal (Vol. 14, 1924, pp. 674–675). Neither subject matter nor maps, however, have been as systematically worked out nor as graphically presented as in Mr. Coy's volumes. Another important investigation of the historical geography of counties is that of Edward B. Mathews, "The Counties of Maryland, Their Origin, Boundaries, and Election Districts," *Maryland Geological Survey*, Vol. 6, 1906, pp. 419–572.

EUROPE

Old Ports of Andalusia. Dr. Otto Jessen visited Andalusia with Professor Schulten to seek the site of Tartessos, the ancient Tarshish. Dr. Jessen's part was to look for geological evidence, and he has written a report thereon (Südwest-Andalusien: Beiträge zur Entwicklungsgeschichte, Landschaftskunde und antiken Topographie Südspaniens, insbesondere zur Tartessosfrage, *Petermanns Mitt. Ergänzungsheft No. 186*, 1924). Tartessos was not actually found, but Jessen thinks it was on a sand bar at the mouth of the Guadalquivir below Seville, much in the position of Sandy Hook with respect to New York except that Seville is four times as far up the river as New York is. A late Roman fishing village was excavated on the inside of the bar island, and Jessen thinks Tartessos may lie deep under the high dunes a little farther out.

Most of his paper consists of a minute account of the details of the region's geology, but it contains also very interesting data on the ports of southwest Spain.

The gentle curve of Spanish coast from the Portuguese frontier toward the Strait of Gibraltar is composed of a long festoon of coastal sand bars fronting Andalusia—the vale of the Guadalquivir—from the western outliers of the Sierra Morena in Portugal to the westward extension of the Sierra Nevada on the Strait.

Three Phoenician or pre-Phoenician ports dominated this coast from an early date: Huelva, ten miles up the Odiel-Rio Tinto, where the Phoenicians opened up the still important copper mines; Tartessos, the oldest, just inside the mouth of the Guadalquivir, from which the Phoenicians traded to Britain and the Baltic for tin and amber and down the African coast for ivory and gold; and Cadiz, on the first outlying ridges extending westward from the Sierra Nevada, on a rocky islet.

Huelva, founded to handle ores of Rio Tinto, has always lived for that alone. Since 1870 the new development of the mines by foreigners and the construction of railroads have given the little city—17,000 inhabitants—an active, modern life. Tartessos, enormously wealthy by its Atlantic trade and the consequent development of wine and olives in Andalusia for exportation, was destroyed by the Carthaginians in B. C. 500, its rich commerce passing to Cadiz.

The five centuries that followed were the first blossoming time for Cadiz. Always foreign, in succession Carthaginian, Roman, and Visigoth, when it came under the non-maritime Moors it quite lost importance. A second blooming time came to it a thousand years later, when the Council of the Indies was shifted there from Seville and it began to handle the very profitable Spanish monopoly of trade with America. Considerable activity animates the city today, though it is actually too maritime in its situation. Being situated on a narrow, rocky islet in the actual waves of the Atlantic, its scant five square miles of area are crowded by its 77,000 inhabitants, so that they have had to build their houses many stories high. Rail connection with the hinterland is imperfect, so that the main traffic is of passengers, freight going on up the Guadalquivir to Seville. But Cadiz too is active, unique in its lofty, tower-capped white houses, and modern of aspect since the English destroyed the city of 1596. Food and even water come to the modern town mostly by sea, a Roman aqueduct having been allowed to fall into ruin.

Back of these characteristic shore footholds of the ocean-trading Phoenicians lay Seville, 50 miles up the Guadalquivir, in the midst of Andalusia's vineyards and olive groves. Typically it was reserved for the land-developing Romans to bring it to importance, and typically in this land of burning skies and scanty rains it was for the irrigating Moors to give it its first period of high prosperity. The second came after the discovery of America with the trade monopoly fixed on the city in 1501. Today a third is in full swing under the impetus given to Andalusian trade by the construction of Spanish railroads. It is an active, modern city of 200,000 inhabitants.

While the present activity of Seville is perhaps the soundest and the most Spanish of these bursts of prosperity, the whole history of these ports is characterized by an *externalism* as great as that of Gibraltar. Spain throughout has had things done to her by outsiders. Tyre and Carthage developed the mines of the Rio Tinto and the trade on the Atlantic, the Romans and the Moors brought water and irrigation works that have declined and fallen into decay as their builders passed from the scene, the Genoese Columbus thrust into the hands of Spain the trade of an empire which she could not keep, and the present activity of mines and railroads has been inaugurated by foreigners from the north.

Even flourishing Seville has not been able to straighten her winding, shallow river by finishing works begun forty years ago to let large ships come up to her wharves, nor to build proper defenses for the city against recurring floods in the river. Cadiz cannot stir herself to sufficient activity to supply herself with much needed railroads.

It is easy to attribute all this to the sloth of the Spaniard, but he is not slothful. I am inclined to wonder if it be not rather a terrific discouragement of initiative that fortune has so many times thrust wealth into the hands of these people without bidding them to exert themselves, just as of all American countries Peru and Mexico appear to have been cursed by their abundant gold and silver.

MARK JEFFERSON

Rock Streams in the Engadine. In a paper entitled "Les coulées de blocs du Parc National Suisse d'Engadine," André Chaix describes four occurrences of rock stream of unusual type (extract from *Le Globe, Mémoires*, Vol. 72, Geneva, 1923). They were first called to his attention in 1917 in the Val Sassa at the National Park. Because of its accessibility the flow in the Val Sassa was first studied, after which the three others came under observation. Three years were occupied with the studies, 1918, 1919, and 1921. In general, each of the *coulées* consists of moraine-like material and detritus lying beyond and downstream from the glacier occupying the head of the valley. It is believed that the glaciers here had in former times a much greater

extent than is now to be observed. A previous examination by Professor Mercanton led him to believe that the movement of these flows was largely due to the lubrication between the particles furnished by the melting of remnants of ice from the earlier glacier still buried beneath the material of the *coulée de blocs.* Dr. André Chaix and Professor Émile Chaix have arrived at a somewhat different conclusion, believing that the rock flows are deposits once contained in the beds of glaciers, formerly of greater extent, and that the downstream creep of these deposits is a continuation of the original motion of the glacier. They also believe that the present glacier is not supplying fresh material.

Measurements to ascertain the rate of motion of the *couleé* in the Val Sassa showed that like a glacier the median portion of the mass moved faster than the lateral, the velocity of the former part being about two meters a year and that of the latter 0.23 meters a year. The method of determining the different rates consisted in spotting a line of stones with paint at right angles to the direction of the flow. A separate color was used for each year.

The four flows of the Val Sassa, Val dell' Acqua, Piz Quater Vals, and Val Tantermozza are described in detail, and comparisons are made with similar phenomena elsewhere. The streams of stones in the Falkland Islands, the rock rivers of the Urals, and the rock glaciers of the San Juan Mountains, Colorado, are among those compared with the Swiss flows. Chaix considers the rock glaciers of the San Juan Mountains as not greatly unlike the *coulées de blocs.*

EDWARD S. C. SMITH

AFRICA

Rural Habitations of Tunisia. In the Regency of Tunisia France directs the affairs of nearly 2,000,000 natives. An inquiry into the way they live has recently been made at the command of the Resident General. The results are analyzed by Augustin Bernard under the title "Enquête sur l'habitation rurale des indigènes de la Tunisie" (Tunis, 1924). A similar piece of work was undertaken for Algeria in 1921.

According to the inquiry Tunisia has some 66,000 city houses accommodating 350,000 persons, a city being an agglomeration of over 2000 persons. This is a high percentage (18) compared with Algeria (6): but since the days of Punic Carthage urban life has been well developed in Tunisia. The rural population is classified into four groups according as use is made of tent, *gurbi*, house, or "cave" type of dwelling (grotto and *ghorfa*). The numbers of these forms of habitation (and their users) are: tents 79,000 (419,000); *gurbis* 108,000 (572,000); houses 90,000 (477,000); grottos and *ghorfas* 19,000 (100,000).

In the northern part of the Tell the tents are few in number and chiefly those of nomads from the south: long distance migrations, however, have little place in Tunisia. Along the eastern coast the influence of the sea is reflected well to the south. From Mahrés, south of Sfax, along a line running northwest into the interior we enter the steppe region proper, and here the tent is dominant. In the extreme south, however, as the land becomes more arid pastoral industry diminishes, and the country is almost empty outside of the oases. Here the tent is occupied for part of the year only.

The *gurbi* is usually regarded as an intermediate form between tent and house; whatever the materials, it is a relatively poor type of dwelling. In Tunisia there are two main sorts, the *maamra*, found chiefly in the north with walls of masonry or *toub* and roof of thatch, and the *kib*, found chiefly in the south, a hut of branches or straw. In the north the *gurbi* occupies large areas to the exclusion of all other types. Toward the south it mingles with the tent in the interior, with the house

on the littoral. In the southern oases it forms a sort of annex to the village, and here style and usage have perhaps been influenced from the Sudan.

In Algeria three house types are distinguished—the European form, the tile-roofed house of Kabylia, and the terrace-roofed house. In Tunisia only the last, the normal type for northern Africa, is of importance. The house-dwelling population is concentrated especially in the *sahel* zone, the low fertile plains bordering the east coast and highly suitable for arborescent cultivation. The houses are grouped for the most part, the agglomeration being commonly determined by the existence of a spring. In the steppes of the center and south, indeed, this control of settlement is quite tyrannical in its operation; but even here safety has sometimes had precedence as in the *ksurs*, veritable "eagle's nests" in the southern mountains. In the island of Jerba, however, the population lives dispersed in the flourishing gardens.

In the extreme south are two remarkable types, the troglodyte dwelling and the *ghorfa*. At Jebel Dwirat caves have been excavated in the soft marly layers interspersed in the chalk cliff. At Matmata the population strictly speaking lives at the bottom of a hole. A pit five to ten meters deep is sunk in the loess; this constitutes the all-important court off which rooms are excavated. A winding tunnel leading to the flank of the hill gives an easily defended access.

The *ghorfa* is built of a series of long, narrow, low-vaulted constructions placed one on top of another, two, three, four, or more stories in height. The idea is essentially derived from the subterranean dwelling of the Matmatas. It is an artificial cliff erected in the open air. Médenine furnishes a well known example (see Figs. 7 and 8, p. 194). One might compare the cave dwellers in the loess of China who when a natural cliff is unavailable excavate a pit dwelling (see M. L. Fuller and F. G. Clapp: Loess and Rock Dwellings of Shensi, China, *Geogr. Rev.*, Vol. 14, 1924, pp. 215–226).

The usage of the several types of dwelling has undergone considerable change. Since French control has brought increased security the more permanent types of dwelling are increasing. The number of tents has generally diminished. The difficultly accessible *ksurs* of the southern mountains are being abandoned. About 40 years ago the Matmatas began to replace their subterranean dwellings by houses built above ground. The *ghorfas* are commonly used as storehouses, especially for the safe-keeping of family goods while the nomad population is away.

Exploration in the South of the Libyan Desert. Another journey breaking new ground in the Libyan desert is that made by Mr. D. Newbold (District Officer in northern Kordofan) in August to November of 1923 and described by him under the title of "A Desert Odyssey of a Thousand Miles" in the July, 1924, number of *Sudan Notes and Records*. The journey was from Bara, western Kordofan (latitude 13° 40′ N., longitude 30° 25′ E.) northwestward to Bir Natrun (latitude 18° 10′ N., longitude 26° 45′ E.).

The country south of Bir Natrun has been practically closed to travel until Darfur came into British hands in 1916 and the Arab caravans could go thither more freely to get their salt. Then "information began to trickle in of various wonders to be seen up in the corner on the map where the boundaries of Dongola, Darfur and Kordofan meet, and in the deserts beyond; a mountain of three days' journey from North to South overrun by wild sheep and with its slopes littered with relics of the aboriginal 'Anag'; a brick 'temple' like the 'temple of Jebel Barkal,' situated 15 days West of Omdurman; rock pictures engraved on cliffs and ravines; stone cairns innumerable surrounded by bones and pottery; sand-dunes that give forth reverberations like tribal drums; pinnacles of rock shaped like weird animals and *efrits;* sudden sandstorms that dry up the water in a skinbag in an

hour and drive the unwary traveler, bemused and athirst, far out of his course." The journey proved the essential truth of all these wonders.

The first part of the route (to latitude 16° 45′) was for the most part through the country grazed by the Kababish, the largest tribe of northern Kordofan and owners of 26,000 mature camels and 150,000 sheep and goats. The northern portion of their territory (from 15° 30′) is *gizzu* country, so named after species of grasses. It is a mass of old sand dunes fixed during a relatively wet period. A later return towards more arid conditions eliminated trees and thinned the bushes, but it is green with grasses from the end of the rains in September until April. The camels migrate thither for this season, spreading out over an area of some 24,000 square miles. Mr. Newbold witnessed the departure of one group of 2000 to 3000 camels. They were accompanied by young men and boys and a sprinkling of women and followed by dogs and a few donkeys who eat the *handal* melon that flourishes on the *gizzu* and resembles the *tsama* of the Kalahari. No tents were carried, but a few carpets were taken as shelters for the more luxurious. The migrants take grain with them and drink camels' milk. The Arab can live on milk for any period. He does not disdain water, however, and will remain within reach of the rock wells until they dry up. "Water is convenient for sick camels, and the Arab washes sometimes." In general, however, the camels go without water for the entire period of six months. The cold of the nights is the greatest hardship of the life on the *gizzu*.

The surface of the *gizzu* is firm, the dunes presenting gentle undulations and relatively flat tops, recalling on a smaller scale the *bulta* of the Kalahari. On the outward journey the western edge of the Jebel Tageru was skirted for 80 miles from south to north. The Jebel covers over a thousand square miles and presents a steep scarp of 300 feet on the western face. The going on the glacis of the scarp was rough and stony but was followed by the party in search of a water source. This was found four and a half days from Bir Natrun. It is a catchment of rain water which filters through the porous rock to an open-air pool in the wadi bed and dries up later in the season. From this point Barbary sheep were seen on the mountain.

Leaving the *gizzu* the expedition passed out of what the Arabs call "guaranteed" country into the "no man's land" of the desert. The Wadi Howa was crossed at an elevation of 1670 feet. This famous wadi is here a sandy valley seven or eight miles broad supporting a growth of bushes and grasses. Scattered heaps of pottery, bones, and stone implements on the northern slope of the wadi revealed the sites of ancient habitations. It may be presumed that in earlier times when a water supply was available these sites were occupied by the fashioners of the rock pictures seen at Zolat el Hammad, 30 miles farther on. The petroglyphs of Zolat el Hammad, like the ones described by Hassanein Bey at Owenat (see *Geogr. Rev.*, Vol. 15, 1925, pp. 141–142), while showing a great variety of other animals, do not include camels: hence it is deduced that they cannot be later than the first century B. C. Mr. Newbold attributes them to South Libyans, who formed the ruling caste in Ethiopia in the Merotic period. Here also were seen the curious rock weatherings of the Arab reports. East of Zolat el Hammad is the Jebel Rahib covering several hundred square miles and consisting of low ridges of blackened sandstone. It is famous for its dunes, said to utter a roar like the boom of the *nahass* or tribal drum. This instance is not mentioned by Lord Curzon in the comprehensive list of "singing sands" given in his "Tales of Travel."

Bir Natrun was approached cautiously, for it has been the scene of many encounters even in recent years. The oasis, however, was empty. It is a barren spot with two or three large salt pans, three tiny clumps of vegetation, and four distinct well areas. From a lookout the way was pointed to the large oasis of Nekheila, 75 miles to the northwest. It is known to the Arabs but has never been visited by

white man. The route from Nekheila to Owenat may be conjectured from native information and "it is probable that there are even in this inhospitable and uttermost desert one or more unknown oases."

The return journey was made along the eastern edge of the Jebel Tageru, which unlike the western border exhibits sandy slopes and is broken by defiles. At one point was found a rock well and rock pictures (no camels). Southeast of the end of the Jebel is Abu Sofian with many antiquities—rock pictures (with camels), a small brick pyramid and other ruins, and graves. Mr. Newbold believes that the archeological discoveries vindicate the theory of continued migration into the northern Sudan of desert people, "Anag" and "Abu Qonaan," from the northwest from the earliest times by which a Hamitic strain, still strongly marked, has been introduced into the southern population.

Reference might here be made to "The Dakhla-Owenat Road," by W. J. Harding King, in the February number of the *Geographical Journal*. An old caravan road runs between Dakhla and Owenat. Mr. King traced it for 200 miles. It appears to have been much traveled; and Mr. King is of the opinion that some intermediate well or oasis must have existed between the two points, which are 375 miles apart in a straight line. He suggests the best approach would be from Bir Natrun. "If the native reports are to be relied upon, there are several new places waiting to be found in this part of the desert."

POLAR REGIONS

The Amundsen-Ellsworth Polar Flight. The "Amundsen-Ellsworth Polar Flight" is being sponsored by the Aero Club of Norway. The expedition, under the leadership of Roald Amundsen, plans to sail from Tromsö, Norway, for Spitsbergen during the early spring of 1925. The Norwegian government has contributed the sum of 70,000 Kroner ($10,000) to the expedition and placed at its disposal the navy transport *Farm* (not the *Fram*). This vessel will be anchored off Spitsbergen to act as a mother-ship for wireless communication during the flight to the Pole.

The expedition is equipped with two Durnier-Wahl all-metal hydroplanes fitted with skis to land on ice. They were built in Pisa, Italy. Each plane has a spread of fifty feet and can develop 640 H. P. from two Rolls Royce motors arranged tandem. Each plane will carry three men, a pilot and a mechanic, with Captain Amundsen as an observer in one plane and I in the other. The expedition is entirely Norwegian with the exception of myself.

The expedition plans to use Spitsbergen as a base until the latter part of the summer, conducting trial flights there until the expedition's meteorologists consider weather conditions satisfactory for the trip to the Pole.

From Spitsbergen to the Pole is a distance of 600 miles, or about 7 flying hours. If a landing can be made at the Pole the expedition plans to carry out observations there for 24 hours. Should, however, any mishap befall the expedition in the vicinity of the Pole the nearest land is the Greenland coast, 400 miles away, where Captain Amundsen has a cache at Fort Conger. But, with 24 hours of daylight and an estimated sea-level temperature of approximately freezing at the North Pole for July, it is acknowledged by critics that flying conditions should be more favorable over the Arctic than over the north Atlantic during the summer months.

Upon the return to Spitsbergen, should the Polar flight prove successful, it is the desire of the expedition to attempt the trans-Polar flight to Alaska. It is 1800 miles, or about 21 flying hours across the Polar sea from Spitsbergen to Alaska.

LINCOLN ELLSWORTH

First Report of Rasmussen's Expedition. Press reports from Science Service contain the first detailed account of the Danish Fifth Thule Arctic Expedition led by Knud Rasmussen, with Peter Freuchen second in command. In the expedition's motor ship, *Søkongen*, the expedition left Copenhagen in June, 1921 (see the note in the *Geogr. Rev.*, Vol. 13, 1923, pp. 625–627). The leader returned via the United States late in 1924. Headquarters were established on "Danish Island" (Lyon Inlet) on the Arctic Circle and in longitude 83°50′ W., just east of Vansittart Island. From there parties visited the area northwest of Hudson Bay, the Melville Peninsula, the Barren Grounds, Boothia Peninsula, and adjacent areas where white men seldom penetrate. The longest and most adventurous journey of all took Rasmussen and two Eskimo companions with one sledge right across Arctic Canada from the Magnetic North Pole to Bering Strait. Every known Eskimo tribe was visited by one or the other of the parties, and the dog sledge journeys totaled 20,000 miles. It is thought that the primeval home of the Eskimos was discovered. In the headquarters region are two culture strata—an earlier stratum related to a larger and now extinct race, the Tornit, that inhabited fixed winter dwellings made of whalebone and turf and located in high situations as if on a shore line from which the ocean had receded from 30 to 60 feet. The later culture stratum is represented by the shore-dwelling Eskimos of today. Through the relatively narrow space off the northern end of Hudson Bay an immense migration seems to have taken place, as shown by the cultural elements collected by the expedition and by the large number of dwelling sites that bestrew the coasts. Of immense importance to science was the study made of the Hudson Bay Eskimo, for the extension of railways and trade to more northerly termini will inevitably destroy or alter cultural values of critical importance to anthropology. In the Barren Grounds between Chesterfield Inlet and Yathkied Lake are five Eskimo tribes, two of which inhabit the coast in the spring and summer, the remaining three being inland people who have but recently begun to move toward the sea. The sole means of subsistence of the inland tribes has been caribou hunting and salmon fishing. Stone huts are unknown, and the snow huts are unheated for want of blubber. The Padlermiut near Yathkied Lake inhabit an extremely cold and windy site. Their boats are different from the customary kayaks, and they hunt the caribou in them at the stream crossings during the great seasonal migrations. Their food supply is irregular; starvation is common, with attendant cannibalism. One Eskimo had eaten his younger brother and another his wife. By contrast the coast Eskimos go inland for the caribou season in summer but return to the coast where food is more abundant in the winter and where there can be collected a blubber supply for the lamps. The caribou skins are invaluable for clothing in a region where three days in four are marked by heavy snowstorms and a temperature ranging from −20 to −50° (C. ?).

The songs, legends, and folk-lore gathered by the expedition will serve to recreate the life of the race, and for comparative studies, with their bearing on racial origin and migrations, they are of extraordinary value. The system of complicated taboos that centers round Nuliajuk, the powerful goddess of hunting who lives at the bottom of the sea, are especially described. Of great historical interest are the Eskimo reports of earlier expeditions, for example, Ross in 1830. Fresh in their memories are the fate of the three last survivors of the Franklin Expedition on King William's Land, Rae's first visit to Pelly Bay in 1847 and again in 1854, Hall's journey of 1869, and Schwatka's journey in 1879 to King William's Land. At Starvation Cove Rasmussen buried the bones of some of the members of the Franklin Expedition.

Among the tribes west of Chesterfield Inlet toward Coronation Gulf murder is common, owing partly to accusations of sorcery, partly to the rivalry for women, whose marked scarcity is due to the strangling of girl babies. In some tribes half

of the men are murderers, and the Royal Canadian Mounted Police send out Arctic Expeditions every winter to apprehend criminals.

All the people between the Magnetic Pole and Baillie Island are even today more closely associated with the inland Eskimos than with the coast Eskimos. "The terror of the Indians is still in their blood." Many of their traditions point toward Greenland, and others toward Alaska. A surprisingly large number of their myths correspond to those known in Greenland. Rasmussen could speak with all the Eskimo from Greenland to Siberia, so similar are their dialects, a fact which suggests a common ancestry. Despite differences of habitat and the lapse of centuries there are many common qualities of speech, tradition, and folklore. Of curious interest is Rasmussen's account of the Alaskan Eskimo, who have been changed by domestic reindeer herding and the coming of sealers and whalers. Here the old songs and folklore persist though it is fast passing among these primitives: almost every man owns a schooner and is addressed as "Captain." The frame house with stove and chimney has displaced the old habitation with its blubber lamp.

PHYSICAL GEOGRAPHY

Orographic Rainfall. One of the most illuminating discussions of the rôle of mountains in the formation of rain has recently been presented from the French point of view by E. Bénévent (*Rev. de Géogr. Alpine*, Vol. 12, 1924, pp. 173–187, Grenoble). The Bjerknes ideas as developed in Norway are used and extended to explain hitherto imperfectly understood features of the rainfall of southeastern France. The relatively heavy rainfall of mountain masses compared with that of surrounding lowlands is generally known to be owing to the concentration of upward movement of winds by the mountains. There are four general types of rainfall: warm front, cold front, instability, and orographic. No explanation of the distribution of rainfall in and about mountains can be complete without some appraisal of the orographic influence in conjunction with each of the others. When a warm front approaches a mountain lying about parallel to it the cold air over which the warm is rising cannot retreat readily and so becomes more or less pocketed and continues the warm front rainfall for some time in front of the mountains. This seems to explain the considerable rise in rainfall on the French piedmont even at some distance from the mountains. When the warm front has passed and the cold air has been blown away there will still be simple orographic rainfall on the mountain face. Cold-front rains are intensified on mountain faces by the localized upforcing of the more or less entrapped warm air as the cold wedge approaching along the ground nears the mountain. And there may be slight orographic rainfall after the cold wind is established. The instability rainfalls are sharply localized where overturning or potentially overturning winds run up a mountain slope. Such rains occur when under any conditions the lower portion of the rain-making wind becomes appreciably warmer than the upper. This can happen either with a running of warm air under cooler, such as commonly occurs with warm south winds at a moderate height, or with the warming of the lower portion of an air stream in contact with the earth's surface. The localization of such rainfalls may bring 30 millimeters or more of rain in 24 hours on the windward face of a mountain as compared with usually less than 5 millimeters by orographic effects without the addition of instability. The unstable wind tends to bound over the mountains, while the stable one tends to flow around rather than go over.

Charles F. Brooks

Tidal Waves, So-called. The tidal wave, so-called, may be brought about by various agencies, but excepting in name it has nothing in common with the tide; it is in no way due to the tide-producing forces, and it does not possess the periodic-

ity characteristic of the tidal movement. The appellation, however, has become so firmly established in the English language that, in spite of it being a misnomer, no other general term is used to designate the destructive waves of the sea that at times overwhelm coastal regions.

In a recent paper entitled "Les Raz de Marée" published in the *Revue Générale des Sciences* (Vol. 35, 1924, pp. 293–299) Professor Edmond Rothé of Strasbourg discusses the different types of tidal waves. He directs attention to the fact that, while the geographic configuration of a coastal region has a modifying influence, the character and intensity of the phenomena differ greatly, depending on the causes which are either meteorologic or seismic. Three general types of tidal waves are distinguished by him. The first type is that due to waves of unusual size or to unusually high stages of the water brought about by severe storms but with no indications of seismic disturbances. It is with this type that we are familiar on our Gulf coast, and as examples we may cite the tidal waves that wrought destruction to Galveston in September, 1900, and to Corpus Christi in September, 1919. In the Galveston storm of 1900 the wind exceeded a velocity of 100 miles an hour, while in the Corpus Christi storm of 1919 the wind attained a velocity of 80 miles an hour. The destruction wrought by this type of tidal wave is the result of the combined force of wave, floating wreckage, and wind.

The second type of tidal wave distinguished by Rothé is that accompanying a seaquake whose epicenter is located not far from the coast affected. If the seaquake results in the subsidence of an area of the ocean floor it is obvious that a movement of the waters towards this area must take place. Hence if this depressed area occurs at a moderate distance from the coast there will be an initial recession of the water from the shore, to be followed later by the wave that inundates the shore. The well-known earthquake of Lisbon in November, 1755, may be cited as an example. If the depressed area occurs close to the coast, the waters coming from the open sea completely overwhelm the incipient retreat of the water from the shore. In this case, therefore, the tidal wave resulting is not preceded by an initial recession of the water from the shore. Obviously tidal waves of this second type are to be looked for in coastal regions where subsidence of areas of the ocean bottom may be expected—in regions of deeps or of steep slope—as, for example, along the coast of Chile or that of Japan. In answer to the question whether the hypothesis of subsidence can be substantiated by known facts, Rothé points to the character of rupture of telegraphic cables, which frequently accompanies tidal waves of this type, as decisive proof.

Under the third type of tidal wave Rothé classes those arising from a seaquake whose epicenter is at a considerable distance from the shores affected. The destructive tidal wave along the Chilean coast of November, 1922, had its origin in a seaquake centering to the north of Chile. Similarly the tidal wave experienced in Hawaii in February, 1923, apparently originated in a seaquake near the Aleutian Islands south of Kamchatka. In such cases he is of the opinion that a wave from the region of the quake is propagated in a particular direction and that the coast lying in the path of this directed wave will experience a tidal wave. In calling attention to the fact that certain volcanic phenomena bring in their wake tidal waves he states that these always arise through the agency of a subsidence, and he instances the earthquake at Krakatoa in August, 1883, as a case in point. In conclusion he cautions against accepting the classification of tidal waves as rigid, since there are many instances which are apparently of an intermediary character.

H. A. Marmer

Plans for Oceanographic Research. The Navy Department of the United States has settled upon a project for systematic oceanographic exploration, broader in scope than previous enterprises of that type. The plan is the outcome of discussions

and conferences held during the past few years, the most important of which was convened in July, 1924, and the results made available late last year in a mimeographic report entitled "Conference on Oceanography, 1924." An impressive list of participants is given and an abstract of the remarks of all the participants. While advice was sought from unofficial sources, the members of the conference were exclusively officers of the Government.

For those who wish a shorter statement of the status of the naval plans, reference should be made to an editorial by Dr. David White, Chairman of the Division of Geology and Geography, National Research Council, in the *Journal of Geology*, Vol. 32, No. 8, 1924, pages 690–695. Here is given in condensed form the expectations of the sponsors of the plan regarding the study of plant and animal life at sea, its distribution, relative abundance and interrelations, and what a knowledge of sea life may mean when the increasing population of the world will require the methodical exploitation of oceanic food resources. Dr. White emphasizes the fact that to the geologist the principal source of interest lies in the abundant data that may soon become available on submarine topography and structure. Of course the usual physical and meteorological observations are included within the scope of the plan. In order to secure real scientific results detailed exploration will be pursued in a given region in contrast to extensive reconnaissance cruises in different parts of the world; and the conference recommends first attention to the Caribbean and Gulf regions and the exploration of the tract reaching to the Azores on the one hand, and to the Panama Canal and the Galápagos and Hawaiian Islands on the other. The results will be published by the Navy Department or under such regulations as its Secretary may prescribe.

Reference should here be made to the work of the Committee on Pacific Explorations of the National Research Council. Progress is reported in coöperation with the Navy representatives and with the Bishop Museum of Honolulu. The last-named has organized expeditions with special objects in view and with the coöperation of Naval officers at Pacific stations, though the Pacific investigations of the National Research Council are independent of the researches of the Navy Department so far as administration is concerned.

The reader should supplement the report of the oceanographic conference of the Navy with a paper entitled "Chart Making by Echo and Bomb," by Commander N. H. Heck of the Coast and Geodetic Survey, which was presented before the Board of Surveys and Maps on December 9, 1924. In it there is a further description and application of the sonic depth-finding apparatus developed by Dr. H. C. Hayes of the Navy Department and described in the Supplement to the *Geographical Review* for October, 1924. Commander Heck's paper is of special interest because of his description of the use of a sound wave generated by a bomb fired electrically near a vessel in order to determine the position of the vessel. A hydrophone is installed at a place whose position is accurately determined from observations on shore objects. By discharging the bomb from the vessel (whose position is unknown, as at night or in a fog), the time required for the sound to travel from the vessel to the hydrophone and to the shore enables the mariner to obtain his position. The results of a combination of the electric bomb and the sonic depth-finding apparatus will be a great improvement to coastal navigation. Their development in the naval research plans and otherwise will see a great extension of our knowledge of the shore zone.

Climatic Cycles and the Numbers of Animals. In every line of scientific progress there are certain periods of abundant harvest. This seems to be the case at present with climatic fluctuations. During the past generation the nature and length of climatic cycles and their various types of organic activity have been much discussed. Their effect upon animal life, however, has received less attention than their effect upon geological deposits, plants, or human activities; hence the particular

interest of Mr. C. S. Elton's contribution, "Periodic Fluctuations in the Numbers of Animals: Their Causes and Effects" (*British Journ. of Experimental Biology*, Vol. 2, 1924, pp. 119–163).

Mr. Elton begins with a brief summary of our knowledge of short climatic cycles. He believes that the evidence now leaves little doubt that cycles averaging about eleven years in length are due in the main to solar activity, although other factors may also play a part. He then proceeds to discuss periodic fluctuations in the number of animals. The well-known migrations of the lemmings are naturally one of the first topics to be discussed. The author finds that the migrations of these little subarctic rodents reach a maximum every three or four years. The animals, chiefly young ones, appear to move out from their homes because of overpopulation. They sometimes perish in the sea, across which they attempt to swim, but usually are wiped out by bacterial infections. Their migrations are "analogous to infanticide among human beings as a method of preventing overpopulation." One of the surprising things about the migrations of the lemmings is that the animals appear to migrate at nearly the same times in all the northern regions, not only in Scandinavia but in the northern parts of North America, in Greenland, and in Finland. In other places, such as the Pribilof Islands and Siberia, similar migrations take place, although exact data as to the years are scanty.

It is clear, as Mr. Elton says, that the causes of the cycles "lie either with the lemmings themselves or with their environment." It is possible to suppose that there is an innate periodicity of a rough sort in the life processes of the lemmings so that time after time it requires about the same number of years for their numbers to increase to the point where migration becomes essential and disease becomes rampant. Then the population may be automatically reduced, and the process of filling up the empty lands with a new generation of lemmings may begin once more. But such an explanation, Mr. Elton holds, "is quite untenable. It is inconceivable that such a process could cause synchronised maxima on the various mountain blocks of southern Norway, which as far as lemmings are concerned, are isolated from one another, or again in the different districts of Scandinavia. When we find further that the lemming maxima are practically synchronous all over the arctic regions and the mountains of southern Scandinavia, any such 'natural rhythm' becomes out of the question. Of course the natural rate of increase is a very fundamental factor in determining the size of periodicity into which the fluctuations will fit. The cause of the periodicity must therefore lie with the environment, and here the only possible factor which is acting in a similar way all over these regions is climate. We do not know how this climatic factor acts, whether directly, or indirectly through plants, or other animals, but there can hardly be any doubt that we have here to look for a periodic climatic effect whose period is about 3.6 years on the average, and which acts over the whole of the arctic regions and in the Norwegian mountains. It will be shown later that it probably occurs in temperate regions also."

The yearly fluctuations in the numbers of animals such as rabbits, hares, foxes, and lynxes, may be judged by the number of skins brought in by the hunters. Data of this sort are quite abundant and conclusive. They show that while these animals are more or less subject to a periodicity averaging 3.6 years, a longer period of about 11 years is on the whole much more pronounced. The same is true of mice, which sometimes give rise to genuine plagues such as that of 1581 in Essex and of 1892–1893 in Scotland.

One of Mr. Elton's diagrams (Fig. 7) shows that out of nineteen mouse plagues in Great Britain from 1810 to the present time not one has occurred during the years of maximum sun spots and only two when the sun spots were more than half as numerous as at the nearest maximum, while at least twelve have occurred when spots were close to a minimum.

The way in which the climate affects the mice is well worth studying. Mr. Elton points out four chief factors. First, mild winters favor the mice and leave an unusually large number of animals still alive in the spring to start the next season's population. Second, a mild spring with conditions of rain, temperature, and sunshine such that the old animals remain healthy and the young are not killed by undue exposure to extremes also favors a large population. Third, few things increase the population of mice or any other animals more effectively than an abundant supply of food, especially during the breeding season and while the mothers are suckling the young. This is an indirect effect of climate, for it depends largely upon plant life, a big crop of beech mast or acorns being especially helpful. The right conditions during the breeding season appear not only to favor the health of the young mice but to cause larger litters to be born. Fourth, "a favourable growing season leaves plenty of plant cover in the winter, which gives the mice protection from their enemies. There must, of course, be other factors as well. But the point is that not only are all these factors connected with climate, but the last three are all the result of the same kind of climatic complex during the breeding season."

An interesting feature of fluctuations in the number of animals is their effect on other forms of life. "One of the most striking and universal results [of the variations in the number of mice] is that the short-eared owl (*Asio flammeus*) very soon turns up and gorges on the mice. The owls often stop on migration at places which they do not visit in ordinary times at all. The number of eggs in a clutch in these years is nine to fourteen instead of four to eight, and they have two broods instead of one in the season."

Not only the rodents but fur-bearing animals such as the fisher, mink, wolverine, and skunk, and likewise many kinds of birds and insects fluctuate greatly in number from year to year. So far as data are available, cycles averaging about 3.6 and 11.2 years are dominant, no matter whether the animals are found in high latitudes or low. The beaver, however, forms an interesting exception, for its numbers remain almost constant. But the beaver, more than almost any other animal, is independent of climatic fluctuations. It does not depend on the growth of any given season, but on the bark of trees which grew long ago. When this gives out the beavers migrate. Moreover, they regulate their own water supply by building dams. The case of the muskrat is quite dissimilar. Seton says that in the Mackenzie region in 1900 he and his companions used to catch twenty in an hour after sundown, while in 1907 only seventeen were seen in six months.

Mr. Elton ends his paper by a theoretical discussion. He shows that variations in the number of animals are a peculiarly good indication of meteorological cycles, because they integrate a great number of different factors. Of course plants do this also, but variations in the growth of plants are not nearly so great or so easily detected as are variations in the numbers of certain kinds of animals. Still more important perhaps is the light which the migrations of animals throw on evolution. Suppose that a variation or mutation occurs in a few members of some group of animals. If the number of animals is large and remains so for a few generations, any variation from the standard type will soon disappear. The animals that carry it will breed with others which lack it, and the standard type will soon reassert itself. Suppose, however, that the number of animals is reduced to very small proportions. Then, if a variation occurs, it will have a chance to be preserved, for it may pertain to so large a percentage that animals which bear it may have a chance to breed together. When a period of stress ensues great numbers of animals are killed off. If the mutation is a handicap, the animals that have it are among the first to die. If it is advantageous, it may enable its possessors to survive while the others perish.

Elton's work seems to mark an important step in our knowledge of the relation of animals to their environment. It is of special interest because the periodic out-

pouring of animals from certain centers, and the enormous death rates among other species, which do not migrate, are closely parallel to what happens among human beings. The swarming of lemmings to the coasts of Norway has a certain analogy with the outpouring of the Arabs in the seventh century and of the Mongols in the thirteenth. The wholesale death of rabbits under the stress of climatic cycles resembles the wiping out of whole towns in China by famine, starvation, fever, and plague. Plant ecology, animal ecology, and human ecology are all governed by the same great laws; and all are essential to the understanding of how and why the phenomena of the earth's surface are so peculiarly distributed.

Ellsworth Huntington

The Geography of the Routes of Migration of the European White Stork. An adaptation of the routes of bird migrations to geographical conditions is suggested in a brief article by Armand Mercier in *La Nature* for January 31, 1925, pp. 65–67. The European white stork (*Ciconia c. ciconia* L.) breeds in spring and early summer in Germany and the Baltic countries but winters in South Africa. Details regarding its long annual journey have been gained through the ticketing of individual birds and through the observation of flocks actually in flight. The storks that nest to the east of the Weser River make their way southward through southeastern Europe, across Asia Minor, Syria, and Egypt, thence up the Nile Valley and through the East African lake region into southern Africa. The birds that breed west and south of the Weser, on the other hand, fly through France, Spain, and Morocco, whence they traverse the Sahara from northwest to southeast, following a line of highlands where there is possibly somewhat more water and vegetation than in other parts of the great desert. Storks in migration have actually been observed in the Ahaggar, at In Salah, and between Tangiers and Fez. The northward routes seem to be the same as the southward.

It has been suggested that the birds take these somewhat roundabout routes in order to avoid the difficult passage of the Alps. M. Mercier, however, declares that while this may be true of the eastern route, the western offers in the deserts as great if not greater difficulties than do the Alpine snows. Both routes avoid the crossing of bodies of water and "the detour which characterizes each, is, perhaps, due to a certain repugnance which the storks feel toward flying over the Mediterranean."

HUMAN GEOGRAPHY

The Twentieth Century Transformation of the Rubber Industry. The economic history and present rôle of the rubber industry is unique in many respects. As Fernand Maurette says in his excellent paper, "Le caoutchouc, étude de géographie économique" (*Ann. de Géogr.*, Vol. 33, 1924, pp. 409–429), it is one of the pivots of the industrial and commercial life of the two greatest powers of the globe. The British Empire produces over two-thirds of the world's rubber; the United States imports about three-quarters of the total production (somewhat higher figures are given by the *U. S. Department of Commerce, Trade Information Bull. No. 180*, 1924). It is in consequence of this situation that the Sixty-seventh Congress authorized the Crude Rubber Survey with a view to development of other sources of supply. In compliance the Department of Commerce has sent four expeditions into the field—to the Philippines, Amazon Valley, Caribbean countries, and the Far East (the last for comparative purposes). The present state of affairs has developed with extraordinary rapidity, the last decade and a half having brought about a complete transformation. "It is as far a cry from the isolated existence of the *seringueiro*

in the Amazon forests to the industrial organization of a Malay plantation as from the little workshops of the last century engaged in making waterproof garments to the great factories of Akron."

Up to 1905 only wild rubber was exploited. The output of the Amazon forests held first rank, African exploitation being less regulated and centralized and methods of collecting being still more primitive. In 1910, after the opening up of the Acre territory, the world's production of wild rubber reached its maximum with 75,000 tons, of which Brazil contributed 47,000 tons. At this date the percentage production of wild rubber and plantation rubber was 88 and 12 respectively. In 1922 the reversal was complete, being 8 and 92: the total production was over 400,000 tons. From 1900 to 1912 the taxes on rubber exported from Pará reached an annual average of $15,500,000; for the years 1913–1922 the figure dropped to $9,000,000. Today the value of Brazilian rubber exports is inferior not only to coffee, which goes without saying, but also to sugar, cotton, hides, cacao, and meat.

It was in 1876 that seeds of the *Hevea* plant were sent to Kew. These formed the basis of the great Malayan plantations. Today British Asia possesses 70 per cent of the area planted in rubber, most in Malaysia; the Netherlands East Indies 27 per cent, divided almost evenly between Java, Sumatra, and the other "Exterior Possessions." The total is 1,606,000 hectares; not all of which, however, is producing and about 30 per cent of which is owned by natives.

Marketing of the product has been equally revolutionized. The primary exporting markets of the East have taken on an *entrepôt* character; especially is this true of Colombo and Singapore. At the beginning of the century Liverpool was the first importation market by reason of her connection with the steamship companies operating to the Amazon and with the Lancashire interests in the colonies of the Guinea coast, which ranked next to the Amazon as a source of supply. In the years leading to the war there were important regional markets at Havre, Antwerp, Bordeaux, Amsterdam, and one of rapidly increasing rôle in New York. The war years and post-war years have seen the preponderance of New York in sympathy with the "monstrous" growth of the automobile industry in the United States.

In England London has taken first rank, her rôle being distinguished from that of the others by its intermediary character. The problem in the rubber trade from the English viewpoint is a double one—to assure markets for the harvest in which a vast amount of British capital is involved and not to overproduce. The problem has its agricultural and industrial aspects. An annual cultivation can be replaced, or collection of a wild product can be dropped; on the other hand, adjustments are not easy in the case of a plantation product where five or six years without remuneration are involved. Furthermore, the great bulk of the product goes to markets outside the British Empire. The problem has been solved by "one of those economic triangles so dear to the British economist."

For many years production has exceeded consumption: the post-war slump of 1921–1922 in particular resulted in an acute state of overproduction, for simultaneously much young acreage came into bearing for the first time. The Rubber Growers' Association made various efforts to secure voluntary curtailment of production but with little success. Under the stress of the recent crisis the British Colonial Office recommended the so-called Stevenson Plan to enforce restriction of export. This has been carried out in the British Possessions, but the Dutch have refused to coöperate. The measure presents the usual difficulties of artificial attempts at regulating the laws of supply and demand, as H. Stuart Hotchkiss points out in "The Evolution of the World Rubber Situation" (*Harvard Business Rev.*, Vol. 2, 1924, pp. 129–138). M. Maurette believes solution lies in the expansion of the rubber industry. Mr. Hotchkiss considers that "the pendulum is certain to swing back and forth" between shortage and surplus "until synthetic rubber comes along to upset all calculations."

HISTORICAL GEOGRAPHY

Medieval Jewish Travelers in the Orient. In a series of recent articles and notes, Paul Borchardt throws new light upon certain puzzling passages in the *Itinerary* of the great twelfth-century Hebrew traveler, Rabbi Benjamin of Tudela (in Spain), and on other early Jewish travels in the Orient. Borchardt's interpretation of Benjamin's notes on caravan routes in the Sahara appeared in *Petermanns Mitteilungen* (Vol. 70, 1924, pp. 219–223) and was reviewed in the *Geographical Review* (Vol. 15, 1925, pp. 142–143). A study of routes in Persia and Mesopotamia according to Benjamin and Rabbi Petachia of Ratisbon, who visited Baghdad about 1180, somewhat over a decade after Benjamin's visit, was published in the *Jahrbuch der Judisch-Literarischen Gesellschaft,* Frankfurt am-Main, 1924 (pp. 137–162); a brief note in *Anthropos: Revue Internationale d'Ethnologie et de Linguistique* (Vol. 16–17, 1921–1922, pp. 1056–1057) deals with caravan routes in Arabia.

Writing in *T'oung-Pao* (Vol. 23, 1924, pp. 31–35) Borchardt asserts that Benjamin does not deserve the reproach of inexactitude even in his account of the routes to the Far East. He believes that the Rabbi "mérite comme Marco Polo le nom d'un homme digne de foi," though he makes no claim that the traveler actually visited the Far East in person. We may assume that Mesopotamia was the eastern limit of his wanderings. The Ibrig, or Jabrig, of Benjamin, reached in twenty-three days from Khulam (modern Quilon on the Malabar coast), Borchardt associates with the Jambri of Odoric of Pordenone or the Lambri of Marco Polo, on the northwestern point of Sumatra. This identification seems also to be confirmed from Chinese sources. From Ibrig, Benjamin says it is forty days' voyage to Zin, or China. The Al Gingalah reached on the return voyage after fifteen days (from Ibrig, we may assume, though Benjamin does not specifically say so) may be connected with Mt. Gongalah in southern Ceylon. Benjamin's Khoulon, fifty days from Al Gingalah, may have something to do with Ghubbet Kulun on the south coast of Arabia near Makallah. This point Benjamin places at twelve days from Sebid on the Red Sea, also in accordance with the actual distance.

Interesting remarks in the writings of Benjamin and other medieval Hebrews relating to the Jewish populations in the vicinity of the southern Red Sea coasts of Arabia and Abyssinia are discussed by Borchardt in *Anthropos: Revue Internationale d'Ethnologie et de Linguistique* (Vol. 18–19, 1923–1924, pp. 258–266). The passage in Benjamin's *Itinerary* relating to these Jews reads thus, as we have translated it from Borchardt's German translation: "From there (the Arabian trading town of Sebid) it is eight days to India, which lies on the mainland called the land of B'aden . . . The land is mountainous. There are many Jews there, and they do not live under the yoke of the unbelievers but possess towns and fortresses on the peaks of the mountains, from which they make raids into the land of Haamatum, called Nubia [M. N. Adler, The Itinerary of Benjamin of Tudela, London, 1907, p. 67 (followed by J. K. Wright: The Geographical Lore of the Time of the Crusades, *Amer. Geogr. Soc. Research Ser. No. 15*, New York, 1925, p. 292) erroneously translates this "Lybia"]. Nubia belongs to the domain of the Christians. Heavily laden with booty they [the Jews] return to their homes which are inaccessible to the Christians. Jews from B'aden are found in great numbers in Persia and Egypt."

Since "B'aden" reads "Aden" in some manuscripts and is so given by translators and commentators, great confusion has arisen regarding this passage. It has been found difficult to explain how Jews of the Aden hinterlands and Yemen could make war upon the Christians of Nubia, Abyssinians, without crossing the Red Sea, or how Benjamin could have failed to mention the fact of their crossing the sea had they done so. Furthermore, at this time the Jews of Yemen by no means held the independent position that Benjamin seems to attribute to them. The

reading "B'aden," on the other hand, goes far toward solving the difficulty. This place name is recorded by the Arabic geographers under variant forms in Eritrea and northern Abyssinia. It may well persist, according to Borchardt, in the name of the coastal region of Massawa, now Ma'adem, and in that of the province of Baaden farther in the interior. No difficulty is raised by Benjamin's placing the region in India, for Ethiopia and southern Arabia were often held to be parts of India in antiquity and during the Middle Ages. The Jews, then, may be identified with the sequestered Falasha Jews of northern Abyssinia, and other topographical details given by Benjamin in relation to this part of the world fall readily into place.

To this same region Borchardt looks for an identification of the dread river Sambation of the Talmud and other early Jewish traditions as described by Eldad ha-Dani (the Danite) of the ninth century. The Sambation, or river of the Sabbath, which divided the land of the Jews from that of their enemies, was a stream not of water but of sand. It flowed six days and rested on the seventh and rolled along with it rocks the size of a house to the accompaniment of rumbling thunder. Other reports had it that the stream was one of fire or of hot steam. Borchardt shows that some of the rivers of northern Abyssinia may well have given rise to these legends. The Takazze and Abai divide the land of the Falasha Jews from the territory of other tribes: during the rainy season they flood to a depth of seventeen meters and roll great boulders down their channels with a sound as of thunder. The water is so charged with sand that it appears the color of sand, and there is a great difference between the intense cold of the mountains and the feverish heat of the deep river valleys. Even the name Sambation may be connected with that of the River Soba or Sobat.

Borchardt notes that the Falasha Jews were again described in the seventeenth century by Gerson ben Elizer as dwelling beyond the Sambation.

The Marmara Region: A Study in Historical Geography. Professor T. L. Myres's article on the Marmara Region (*Scottish Geographical Magazine*, May, 1924) abundantly illustrates the geographic principles that a strait is a gateway in a sea route and a break in a land route and that an isthmus is a gateway in a land route and a break in a sea route. Now the Marmara Region, which includes the Dardanelles, the Sea of Marmara, and the Bosporus together with their immediate coast lands, is interposed between Asia Minor and the Thracian Peninsula where these meet except for a narrow rift between; it therefore has an isthmian character. But this great land bridge connecting Europe and Asia arches over a slender belt of sea, so that the Marmara Region marks the crossroads of land and sea routes. It is a transit district, facilitating east-west and north-south intercourse. The latter has been the more important in commerce, because the Straits have linked two regions sharply contrasted in physical features, climate, soil, products and types of civilization; hence they have forwarded active exchanges between these regions since the dawn of history, and have focused on themselves the maritime policy of the commercial powers to the north and south. But the east-west route along the isthmian stretch, as an intercontinental pathway, has been swept by migrating peoples and the advancing armies of great territorial powers. The Marmara Region has been the goal of imperialistic expansion from Europe and Asia; once occupied, it has become the base for a new far-flung frontier. Such it was for the Persians under Darius and Xerxes, as for the Macedonians under Philip and Alexander. Such it was for the Roman advance headed Asiaward and the Turkish advance headed Thraceward; because land powers are habituated to movement along well explored land roads.

Hence the Marmara Region owes its conspicuous place in history to the economic and political developments in the Black Sea and Aegean lands on the one hand, and in the Balkan Peninsula and Asia Minor on the other, though in the latter case the urge for expansion may have originated in the far Danube or Tigris valleys. The

Region itself, small and limited as to resources, has played only a passive part in the struggles between the great land powers for its possession; but when sea powers were fighting for control, its rôle became a leading one. Moreover, the chief maritime cities of the Euxine and Aegean were drawn into the conflict, because they saw peril threatening their access to the abundant raw materials of the North, the forests of the Caucasus Mountains, the furs, cattle, wool, hides and especially the boundless wheat fields of the Scythian plains, which afforded food resources for industrial Greece and became therefore a prime economic condition of Greek life. Undivided control of the Straits has always been inimical to the interests of Aegean and Black Sea lands; hence the recurrent tendency to divided control as the normal and healthy condition. No state has long been able to hold the Marmara Region unless it based its strength upon a vast hinterland in Asia Minor or the Balkan Peninsula or both; or unless it pursued a generous policy in regard to its strategic passway. Any tendency to obstruct the Straits or collect tolls has invited attack. Tenure of the Marmara Region therefore has always been, in effect, a public trust. Its betrayal has aroused first protest and finally reprisal.

Ellen C. Semple

GEOGRAPHICAL NEWS

The Twenty-First Annual Meeting of the Association of American Geographers. The Association of American Geographers met in Washington on December 30 and 31, 1924, and January 1, 1925, for the twenty-first annual meeting. The meeting was held in the main building of the National Geographic Society, through whose courtesy the members of the Association and others attending the meeting were the Society's guests also at luncheon. The sessions were exceptionally well attended, and the program was characterized by careful planning. Of the forty-one papers announced all but one were read, four of these by title only. In addition there were two memorials, and a presidential and a vice-presidential address, these last two being given at a joint evening session and dinner with Section E (Geology and Geography) of the American Association for the Advancement of Science.

The outstanding feature of the meeting was the allotment of an entire day to papers on tropical geography, followed by a round-table discussion in the evening. Several papers dealt with general topics. Professor S. S. Visher of Indiana University discussed "The Rainfall Régime As a Great Handicap to Tropical Development" (to be published in the *Geographical Review*). Professor J. Russell Smith of Columbia University dealt with certain misconceptions about tropical agriculture. In the course of his remarks he referred to "The Agricultural Possibilities of the Canal Zone," by H. H. Bennett and W. A. Taylor (*U. S. Dept. of Agric. Rept. No. 95*, 1912), as an important pioneer American investigation of tropical agriculture tending to dispel such misconceptions. Dr. Helen M. Strong of the Bureau of Foreign and Domestic Commerce spoke on "Changes in Entrepôt Markets for Tropical Products." Her paper was illustrated by a map comparing the pre-war and post-war routes of tropical commodities shipped to the United States. Mr. E. S. Gregg (introduced) of the same bureau dealt with "Transportation Problems in Tropical America," referring to the technique of tropical trade with its special types of vessels —cargo, oil, fruit—and its protection against climate, especially moisture. Professor H. N. Whitford of Yale University discussed "Geographic Aspects of the Production and Consumption of Rubber." On the basis of the world-wide rubber investigation recently made by the Department of Commerce, with which he was associated, he presented a series of maps showing the distribution of rubber trees and also a map with the localities of rubber consumption in the United States. The results of the Department of Commerce investigation will shortly be published as a government

document. Mr. W. J. Showalter (introduced) of the *National Geographic Magazine* spoke on "The Monroe Doctrine and the Countries of the Caribbean."

The remaining papers of the tropical session were regional in character. Dr. C. F. Marbut of the Bureau of Soils and Professor W. H. Haas of Northwestern University both dealt with the Amazon Basin. The latter spoke on "The Physical Conditions of the Inner Amazon Basin," the former on "The Relation of the Amazon Valley to the Future Food Supply of the World" (to be published in the *Geographical Review*). Both papers testified to the value of the researches of Paul Le Cointe (see *Geogr. Rev.*, Vol. 13, 1923, pp. 634–636, and Vol. 14, 1924, p. 467) and his map of the Amazon Basin in 1:2,000,000. Mr. H. H. Bennett of the Bureau of Soils gave an address on "Some Geographic Aspects of Western Ecuador," based on a recent agricultural reconnaissance in the coastal plain and the Andean highland. Professor Preston E. James (introduced) of the University of Michigan dealt with "Geographic Factors in the Trinidad Coconut Industry." After sketching the physical basis of the industry he analyzed the conditions on an individual estate at the tip of the southwestern peninsula. Professor N. A. Bengtson of the University of Nebraska read a paper (to be published in the *Geographical Review*) on "Geographic Phases of the Industrial Development of Honduras." Professor J. Russell Smith spoke on "An Example of Local Variation in Tropical Climate," having reference to the Yuna valley in northeastern Haiti. An extra-American tropical region was discussed in a paper by Dr. H. L. Shantz of the Bureau of Plant Industry on the "Agricultural Potentialities of East Africa."

The majority of the papers of the regular program dealt with North America. Mr. W. D. Collins (introduced) of the Water Resources Branch of the U. S. Geological Survey spoke on "The Relations Between the Quality of Water and Industrial Development in the United States." Mr. Richard Hartshorne (introduced) of the University of Minnesota discussed "The Significance of Lake Transportation to the Grain Traffic of Chicago." In the ensuing discussion it was brought out that direct shipment in ocean bottoms from Great Lake ports would not be feasible in the grain trade because of the time factor. Vessels carrying Dakota wheat to Europe would not be able to return to an upper Lake port in time to load the Canadian wheat crop. Professor G. B. Roorbach of Harvard University in a paper entitled "The Relation of Foreign Trade to Present-Day New England" pointed out the varied factors upon which the recent development of foreign trade in New England is based. "The Dairy Industry of Wisconsin As an Adjustment to the Natural Environment" was discussed by Mr. G. T. Trewartha (introduced) of the University of Wisconsin. Miss Esther S. Anderson (introduced) of the University of Nebraska spoke on "The Beet Sugar Industry of Nebraska As a Response to Geographical Environment." Dr. A. E. Waller of Ohio State University told about the fixing by vegetation of the slopes of the various reservoir dams in Ohio known as the Miami Conservancy.

The admirable paper on "The Future of Alaska" completed just before his death by the late Dr. A. H. Brooks of the U. S. Geological Survey and published in the preceding number of the *Geographical Review*, was read by his colleague, Mr. R. H. Sargent. Mr. Sargent on his own behalf also described a newly discovered crater, Aniakchak Crater, midway on the Alaska Peninsula, with its six-mile-wide *caldera*. By special invitation Dr. Lauge Koch, the Danish geologist, spoke on his recent topographical and geological work in northern Greenland, referring, among other topics, as he did in his lecture before the American Geographical Society on December 23, 1924, to his completion of the circuit of the topographical mapping of the coastal margin of Greenland, to his tracing of the continuity of the ancient Caledonian mountain system of Scotland, Norway, and Spitsbergen through northern Greenland and northern Ellesmere Island (Grant Land). President W. W. Atwood of Clark University spoke on "Physiographic Stages in the Evolution of the

San Juan Mountain Region and Their Correlation with the Physiography of the Front Ranges of Colorado." Another paper on a physiographic topic was that by Mr. F. E. Matthes of the U. S. Geological Survey on "Evolution Basin in the Heart of the Sierra Nevada."

Three papers dealt with the American aborigines. In a general paper Professor W. H. Haas discussed "The American Indian and Geographic Studies." He referred to the desirability of geographic studies of Indian culture because of the relative simplicity of Indian adaptation to environment. The other two papers dealt with archeology—one by Mr. N. M. Judd of the U. S. National Museum on "Prehistoric Pueblo Bonito," the other by Mr. N. H. Darton of the U. S. Geological Survey on "Geologic Evidence As to the Age of the Temple of Cuicuilco near Mexico City." Both areas are being investigated under the auspices of the National Geographic Society.

Of papers on general geography two dealt with cartography. Professor J. Paul Goode of the University of Chicago spoke on "Progress in Cartography in Poland," calling special attention to the rôle of Professor Eugene Romer of the University of Lwów in that progress. Dr. E. L. Stevenson of the Hispanic Society of America, New York, read a paper, illustrated by lantern slides of old maps, on "Certain Erroneous Interpretations of New World Geography As Recorded in the Work of the Early Cartographers." Hydrography was represented by a paper by Mr. H. A. Marmer of the U. S. Coast and Geodetic Survey on "Mean Sea Level and Its Variations." Economic geography was the theme of the address, "A Classification of Natural Resources," by Professor N. M. Fenneman of the University of Cincinnati, retiring vice-president of Section E of the American Association for the Advancement of Science (published in *Science*, February 20, 1925).

Two papers and a presidential address were in the field of human geography. Professor Mark Jefferson's paper on Malthus appears in this number of the *Review*. In his presidential address entitled "The Promulgation, Decline, and Renaissance of Malthusianism and Its Relation to the Character and Geographic Distribution of the Soil," Dr. Marbut called attention to the fact that the present era is characterized by the opening up to agriculture of the black-soil regions of the world. This has tended to offset the increasing exhaustion of the humid soils and to postpone Malthus' predicted diminishing food supply. Professor R. M. Brown of the Rhode Island College of Education, Providence, in an interesting paper entitled "The Attributes of Civilization," pointed out the meaninglessness of a classification of peoples by racial affinities. Instead he suggested a classification by the degree of civilization, viz., into civilized, barbarian, and savage peoples. The threefold attributes of a civilized people he stated to be: collective power through organization, collective knowledge through experience, and collective sympathy. Barbarians have the outward tokens of civilization: they have collective power and knowledge but lack collective sympathy. Savages are peoples of arrested development.

Three papers dealt with regional methods. Professor Wellington D. Jones of the University of Chicago discussed "Detailed Field Mapping in the Study of the Economic Geography of an Agricultural Area," and Professor V. C. Finch of the University of Wisconsin exhibited a detailed map prepared according to the methods outlined by Professor Jones. These call for the differentiation of tilled areas (with indication of kind of crops in each case), areas in permanent pasture, wooded land, waste or idle land, streams, homesteads, transportation and communication routes, etc. In a paper entitled "Human-Use Versus Natural Regions: A Preliminary Report of the Committee on Geographic Provinces" Mr. W. L. G. Joerg of the American Geographical Society reviewed the development of the regional method with special reference to North America and broached the question as to the feasibility of including human factors in the delimiting criteria.

The general question of geographical research was discussed by President W. W.

Atwood in a paper of that title, and President Gilbert Grosvenor of the National Geographic Society gave an account of the Society's recent work and activities. Memorials were read of the two members of the Association who had died since the last meeting, Dr. E. O. Hovey (by C. C. Colby, as published in *Science*, December 19, 1924, by Professor C. P. Berkey) and Dr. A. H. Brooks (by Philip S. Smith; see also memorial by George Otis Smith in *Science*, January 23, 1925).

On the day preceding the Association meeting there was held the tenth annual meeting of the National Council of Geography Teachers. Among the papers read may be mentioned "Geography As a Social Science" by Professor George J. Miller, Secretary of the National Council; "The Ozark Region of Illinois: A Regional Study," by Miss Ina C. Robertson; and "Geographic Principles in the Study of Cities," by Professor D. C. Ridgley of Clark University (published in the *Journal of Geography*, February, 1925).

Numerous papers presented before the American Association for the Advancement of Science, which was holding its seventy-ninth meeting from December 29, 1924, to January 3, 1925, were of interest to geographers, but it was hard to hear these without sacrificing some important feature in the Association's program. For this reason attention may here be called to some of them: "The Navy's Oceanographic Program," by Mr. A. H. Clark of the Smithsonian Institution (published in *Science*, March, 13. 1925); "Determination of Submarine Configuration by Acoustic Methods," by Commander N. H. Heck, U. S. Coast and Geodetic Survey; "The Geology and Physiography of the Red River Boundary Between Texas and Oklahoma," by Professor L. C. Glenn of Vanderbilt University, Nashville, Tenn.; "The Ellsworth Expedition of The Johns Hopkins University Across the Andes of Central Peru," by J. T. Singewald, Jr., and Q. D. Singewald of Johns Hopkins University; "The Big Tree As a Climatic Measure," by Dr. Ernst Antevs; "Observations on the Mediterranean Garigue and Macchia," by Professor J. W. Harshberger of the University of Pennsylvania; "Structure of the Vegetation of Texas East of the 98th Meridian," by Dr. B. C. Tharp of the University of Texas; and "Symposium on Agricultural Conditions in Foreign Lands," embracing Great Britain, Germany, Punjab and Kashmir, Central America and northern South America, and East Africa.

The Russian Geographical Society. A brief sketch of the Society's career through the years 1918–1922, appears in a recent number of its *Izvestia* (Vol. 55, 1919–1923, Part II, pp. 173–198). Amid all its trials, the Geographical Society has kept alive and active under the energetic leadership of Professor J. M. Schokalsky, who has filled the office of President throughout the period. The formation of a new Northern Committee expresses the Society's participation in the present trend toward interest in the possibilities of North Russia. Relations have been reëstablished with most of the outlying branches of the Society cut off by the civil wars. The 1922 number of the Turkestan Section's *Izvestia* celebrates its twenty-fifth anniversary. One noteworthy achievement of the period under review is the establishment, thanks to the Society's initiative, of standard time zones in Russia, bringing the country into conformity with the international system in this respect.

A few expeditions have been organized, among which the most considerable is that of P. K. Kozlov into Mongolia and Tibet. His party set off in the summer of 1923, hoping to push its explorations as far as the upper valleys of the Yangtze and Mekong Rivers. The expedition has recently returned with a rich collection of material. Although publication has been an especially difficult matter in recent years, the Society has been able to print Kozlov's book on Tibet and the Dalai Lama and the account of his Mongolian researches of 1907–1909. Much similar material awaits the opportunity to go to press, including notes of the late N. N. Miklukh-Maklai on New Guinea and Oceania. Another manuscript ready for

publication is that of a volume of sample articles for the Society's revised Geographico-statistical Dictionary. Revision of this dictionary, of which the latest portion dates from 1885, was begun in 1919; but such fundamental changes suggested themselves in the course of the work that it was found advisable to suspend progress until a set of articles prepared under the proposed new plan could be submitted to general criticism.

J. V. Fuller

Obituary

Franz Schrader. Franz Schrader, the veteran French geographer, died on October 18, in his 81st year. A disciple of Élisée Reclus his geographical bent was towards the human side. For 30 years he gave courses in human geography at the École d'Anthropologie and he was the author of many geographical texts. His philosophy might perhaps be summarized from his address "The Foundations of Geography in the Twentieth Century," the first Herbertson Memorial Lecture (*Geogr. Teacher*, Vol. 10, 1919, pp. 44–53): "This ideal of Science must not be *force*, but harmony: and geography, if our hopes are not in vain, will add to the whole of sciences a large contribution to the natural and human harmonisation."

Schrader, however, will be best remembered for his cartographical work. He continued and completed (1893) the first edition of the "Atlas Universel de Géographie" begun by Vivien de Saint Martin in 1876, and brought out the new edition of this excellent work, 1920–1922. He collaborated in the "Atlas de Géographie moderne" (1890) and directed the production of the "Atlas de Géographie historique" (1896). In 1891 he initiated "L'Année cartographique," a record of new work in exploration and cartography.

Schrader's work was colored by his predilections as alpinist and painter, tastes that inspired in particular his notable contributions to the exploration and mapping of the Pyrenees. These culminated in the summary of the structure and relief of the Pyrenees written jointly with Emmanuel de Margerie and accompanied by a geological and an hypsometric map of the whole range on the scale of 1:800,000 (*Annuaire du Club Alpin Français*, 1891 and 1892). One of his earliest works was the detailed "Carte du Mont Perdu et de la région calcaire des Pyrénées central" on the scale 1:40,000 (1874). Forty years later appeared the fine map "Le massif de Gavarnie et du Mont Perdu," 1:20,000. In 1923 at the age of 79 he climbed the 2700 meters to the cirque of Gavarnie to retouch and perfect this work, the dearest to his heart, his Benjamin, as says M. Martel in his obituary notice in *La Nature* (November 29, 1924). Up to the spring of 1924 Schrader was president of the Comité d'Études scientifiques instituted by the French Alpine Club.

Theodor Koch-Grünberg. Dr. Theodor Koch-Grünberg, latterly associated with the Museum für Länder- und Völkerkunde at Stuttgart, died of malaria at Vista Alegre, Brazil, on October 8, 1924. He had joined Dr. Hamilton Rice's present expedition which has the unknown Sierra Parima as its objective (see pp. 264–266). On his return Dr. Koch-Grünberg had planned to spend some time at São Felippe (Rio Negro) studying the myths of the Arawak tribes of the region. The leader of the expedition pays great tribute to his character—"patience, simplicity, courage, and understanding"—and scholarship. "As an ethnologist and student of the South American indigene I know no one of the present generation qualified to rank with him." He had an extensive knowledge of the native tongues of the Amazon Basin and a remarkable faculty for getting on with the natives, among whom he exercised a great influence for good. While his geographical work was subsidiary to his ethnographical studies he made important contributions to our knowledge of tropical South America. Commenting on his mapping and

topographical work, which exhibits characteristic care of detail and attention to method, Dr. Rice says "his results were surprisingly good considering the difficulties he labored under by reason of incomplete equipment, lack of trained assistance and his own rather imperfect knowledge of the subject."

Dr. Koch-Grünberg's most important published works are "Zwei Jahre bei den Indianern Nordwestbrasiliens" (Stuttgart, 1923), a revision of the two-volume work appearing in 1909–1910 and describing the results of the 1903–1905 journey in the Brazil-Colombia boundary region, and "Von Roroima zum Orinoco," a three-volume work on travels in Northern Brazil and Venezuela in 1911–1923 (Vols. 1 and 2, Berlin, 1917 and 1916; Vol. 3, Stuttgart, 1923).

GEOGRAPHICAL REVIEWS

Recent Books on Population

E. M. East. **Mankind at the Crossroads.** viii and 360 pp.; maps, diagrs., index. Charles Scribner's Sons, New York and London, 1923. $3.50. 9 x 6 inches.

E. B. Reuter. **Population Problems.** xvii and 338 pp.; bibliogrs., index. (Lippincott's Sociological Series.) J. B. Lippincott Co., Philadelphia, London, and Chicago, 1923. $2.00. 8 x 5 inches.

A. Andréadès. **La population anglaise avant, pendant et après la grande guerre.** 148 pp. ("Metron" Library; Studies of Statistics and Social Science, Ser. A, No. 1.) Soc. Tipografica Editrice "Taddei," Ferrara. 8 x 5½ inches.

Harold Cox. **The Problem of Population.** ix and 244 pp.; bibliogr., index. G. P. Putnam's Sons, New York and London, 1923. $2.50. 8 x 5½ inches.

Harold Wright. **Population.** With a preface by J. M. Keynes. xiv and 178 pp. (Cambridge Economic Handbooks, V.) Nisbet & Co., Ltd., London; The University Press, Cambridge, 1923. 8 x 5 inches.

The books quoted above, the first two being American, the last three expressing the British situation, show how seriously the question of population is affecting sociological thinkers on both sides of the Atlantic in this period of adjustment to new conditions of equilibrium. When numbers become uncomfortably large, population becomes a problem. Oddly enough, students of the matter are making their important contributions to the question of numbers not in the crowded countries of continental Europe but in America and in England (Adolf Damaschke's "Die Bodenreform," Jena, 1923, however, shows concern about one side of the question). Parts of Europe are in a condition that presents affairs more immediately urgent. Energy is there consumed in action. England and America have time to think, and their thought projects the problem of numbers as an imminent difficulty that will press with ever increasing insistence on the present and the next generations. It is a difficulty that must be faced and understood, if the conditions of living are to be maintained at tolerable standards.

The analyses presented in these volumes are strikingly alike. They converge in a definite direction. The opinions expressed are emphatic but not alarmist. Overpopulation does not impress the enlightened investigator as an actuality of widespread occurrence, but he sees in England a real overcrowding (why use the redundant term *over*crowding, when crowding expresses the idea?) and foresees there, and in America, the likelihood of serious congestion, that will submit our economic organization to a terrific stress. Overpopulation may ensue, if society does not learn to adapt itself to the pressure. Advancing study is broad. It tries to take a world view of things, but the main argument shows a natural trend of nationalism.

East's book is an extension of articles which appeared in the *Scientific Monthly*, and his strong position has not been improved by the extension, except that the volume form makes the work more widely available. The book is inclined to garrulity, but the angle from which it illuminates the problem is so novel that it must take an important place in the literature of the subject. He seems to be the only investigator who attempts to use intelligent maps, though his maps fall short of what one would desire. He is also the only worker who states plainly and to a degree quantitatively, that the habitable regions of the globe are limited in extent. His main argument is that the United States has entered the period of diminishing

returns in agriculture, while the rate of population increase is unabated. There is a lot of genetic material in the book, but, on the whole, it has a more geographical character than most books on population. Thompson, who foresaw the growth of the problem of population before America entered the war (W. S. Thompson; Population: A Study in Malthusianism (Columbia Univ. Studies in Hist., Econ., and Public Law, Vol. 63, No. 3), New York, 1915), has presented the leading results of the census of 1920 in a compressed summary (W. S. Thompson: Population Facts for the United States and Their Interpretation, *Journ. Amer. Statistical Assn.*, Vol. 18, 1923, pp. 575–587). He considers that the measured facts of a decade of increase need give no cause for uneasiness, but Rossiter (W. S. Rossiter: The Adventure of Population Growth, *Journ. Amer. Statistical Assn.*, Vol. 18, 1923, pp. 561–574) has also examined the increase of the United States, endeavoring to ascertain the growth due to natural increase of American stock and that due to immigration, and concludes that the trend is adventurous and that the consequences of the present rates are unpredictable. Reuter's book too, takes up the matter in a similar spirit, from the genetic standpoint. He is concerned with the possibility of a submergence of the desirable by the undesirable elements of the American population. He stresses America's right to determine who shall be the people to fill up her territory.

The English books are oriented towards economics rather than genetics. Andréadès, an Anglophile Greek and a student of English finance, has examined the English census and vital statistics before and since the war. He shows that the war has had comparatively little effect upon the constitution and growth of the population, the recovery from war losses being rapid. He points to two serious elements in the constitution, the large excess of females (the so-called "troisième sexe"), and the present high number of the unemployed. Cox presents the problem of crowding, in Malthusian terms, and offers several means of solution. The book has an amateur stamp; for example, we find references to excess of population, overcrowding, and overpopulation, as the same thing (see the note "Overpopulation: The Limitations of an Idea," *Geogr. Rev.*, Vol. 14, 1924, pp. 315–316); but it is a serious and well considered study, with a good deal of originality. Those passages dealing with the possibility of a more even distribution of population throughout the Empire are particularly important for their wise vision and restraint (see also Harold Cox: The Peopling of the British Empire, *Foreign Affairs*, Vol. 2, 1923, pp. 117–129; Vaughan Cornish: The Geographical Position of the British Empire, *Scottish Geogr. Mag.*, Vol. 39, 1923, pp. 217–229). Cox realizes the difficulty, as well as the desirability of so tremendous a scheme. Wright's little book is an excellent Malthusian statement from the British point of view, a clear introductory study of the subject of population. It has not a little of the geographic spirit so evident in East's volume, and, like each work in the group under review, has something to say which is not to be found in the other volumes.

Books on population make rather monotonous reading after a couple of them have been absorbed. They have a habit (except that of the statistical Andréadès) of telling you all about Malthus, his critics, and predecessors; after which they present the state of affairs today and then launch into eugenics and genetics, to finish with an advocation of birth control. Nevertheless they all seem to contain a good deal of individual wisdom. If a selection from these works be asked for, a geographer should take Wright's book as an introduction and East's as an extended treatise and with their aid could arrive at a sound realization of one of the most interesting questions of the day. As general works of reference, however, none of the volumes reviewed here can approach Carr-Saunders' masterly study of the subject (The Population Problem; A Study in Human Evolution, Oxford, 1922; reviewed in *Geogr. Rev.*, Vol. 13, 1923, p. 496) for sweep and scholarship.

M. Aurousseau

The Geography of North America

J. Russell Smith. **North America: Its People and the Resources, Development, and Prospects of the Continent as an Agricultural, Industrial, and Commercial Area.** viii and 849 pp.; maps, diagrs., ills., index. Harcourt, Brace & Co., New York, 1925. $6.00. 9 x 6 inches.

This book opens with the good Calvinistic doctrine that Hell is hot (with the reassurance in the third sentence that not all hells are hot); illustrates one of its points with a cartoon from *Life* and another with a few lines from Carl Sandburg; refers to the *Literary Digest* about as often as to the newspapers; quotes Clare Sheridan, the sculptor, and Stevenson, the essayist; illustrates successive themes with photographs from almost every important Chamber of Commerce in the United States; and explains the Grand Canyon with the help of a cross section from Fred Harvey! Which is another way of saying that the book is a continuous circus with all the side shows. It will keep classes awake. Even the trained geographer will read it through without skipping a line for, humanly, it is as interesting as a novel. We emphasize its peculiarities at the start since they illustrate one of its outstanding features—unconventionality. A second outstanding feature is its effective use of science—it really bridges the gap between technical jargon and the questing mind that must have its knowledge in plain English. Professor Smith has given us just the book that university geographical departments have needed for twenty years—a regional geography that describes and explains the real people of North America in a style that frequently displays the irresistible quality of genius.

Of all serious books of substantial worth Professor Smith's North America is perhaps the most difficult to describe in terms of a table of contents. The headings represent the bare facts of regional location. The two-page list of them is the only dull spot in the book. Every other page is filled with life, not merely the data of life. Prince Edward Island, births and deaths in a New England mill town, the boll weevil, belated winter rains in California, caribou, and sugar—all alike have a new significance. The geographical values which they exhibit well illustrate one of the most important attributes of geographical science—its point of view. It is science, it is description, it is explanation, it is in part forecast; but it is also a way of thinking. That it is a helpful and constructive way is shown on every page. Upon geography is put the task of making the earth understandable and also more habitable. Not just examples of man as the creature of environment but man confronted with problems to solve and solving them—measurably, conditionally, inventively. Above all, Smith breaks away from the deadlier aspects of pure system. No two chapters are treated alike—because there are no two regions whose outstanding problems are the same. This is a great virtue in a college text, which should excite the imagination and stimulate the creative mind. Though filled with facts regarding the soil, climate, and relief of the different regions of North America, the book reveals an author always in command of his data but rising to something more than a memory exercise. Memory alone can become a curse. Unless ideas prevail the students perish.

It is probable that a substantial list of errors could be compiled for each chapter. They will not be listed here because they are unimportant at this stage. In the next edition they should be rooted out because they are not the fit companions of great ideas and a truly original style. They are not as a rule faults of principle but of form of statement. The sure touch of a trained editor is lacking. References are not always accurate. There is more than a trace of exaggeration here and there. Stefansson will not approve page 660. Many of the maps are bad; a few are atrocious. The idea of breaking up Lobeck's block diagram of the United States (excellent for its original purpose) into regional units is unsound from any standpoint

and an offense to the cartographic eye. Perhaps we expect too much of an author with so vast a field to cover; it is probable that no one man can cover it definitively; a monographic treatment by regions still wants doing. We hesitate to offer even these minor criticisms for fear that the reader may be diverted from the high qualities of the book—at one and the same time a really standard text and a work of art.

The Vegetation of Eastern Bolivia

Theodor Herzog. **Die Pflanzenwelt der bolivischen Anden und ihres östlichen Vorlandes.** viii and 258 pp.; maps, diagrs., ills., bibliogr., indexes. (Die Vegetation der Erde, No. 15.) Wilhelm Englemann, Leipzig, 1923. 10 x 7 inches.

The publication of a new volume in the great series dealing with the vegetation of the earth, for which Professors Engler and Drude are responsible, is an event always to be welcomed. But the appearance of this, the fifteenth, by Dr. Theodor Herzog is specially important for two reasons: first, because with the earlier works in this series by Reiche and Weberbauer and with the more recent paper (*Petermanns Mitt.*, 1922) by the latter, it provides a complete regional botanical survey of the whole of the Central Andes and, secondly, because the eastern slopes and piedmont of the Central Andes, which form Dr. Herzog's field, are shown by him to be a key area in the plant geography of South America—the meeting place of plant formations differing greatly in character and of floras of widely different origin.

Geographically Herzog's work is particularly valuable and remarkable because he is himself one of the few explorers upon whose results we must rely for the very elements of our geographical knowledge of this little-known part of the continent.

The author's introduction to the country was an expedition undertaken on behalf of a development company in 1906–1907. From their point of view the results were entirely negative, and the investigation was curtailed in consequence. The journey had begun at Puerto Suarez on the Rio Paraguay, in a district reputed to produce coca trees which did not exist; thence westward through the rain forest east of the Rio Blanco in the province of Velasco in search of rubber. But this forest explored as far north as 15° S. revealed nothing but inferior rubber species. The author then traversed the plains westward by Santa Cruz to the outer cordillera to the west of it, to report upon the possibilities of cinchona production; but the *montaña* forest was found to have been largely denuded of cinchona trees by earlier gatherers. The foothills here were also said to yield "yerba maté"; but Herzog found that the product was fraudulently so-called, since it was derived from a quite different shrub. These negative facts are in themselves interesting to geography; and science has gained more than commerce lost by that expedition.

The second expedition (1910–1911), undertaken on his own account, had purely scientific aims not entirely confined to botanical work, for Herzog carried out a compass survey over a long distance and made geological and meteorological observations as well. The surveys have been made use of by this Society in the compilation of the La Paz and Santa Cruz sheets of its map of South America. The route lay from Ledesma in northern Argentina along the eastern foot of the Andes and the western fringe of the Gran Chaco to Santa Cruz, but with diversions eastward from Yacuiba to the Rio Pilcomayo and up this river to Villa Montes, as well as westward to examine the forests on the eastern front of the Andes and the more xerophilous vegetation of the ridges and valleys behind the front range. From Santa Cruz the author made a journey along the foot of the mountains where they make their great bend to northwest and also penetrated these unknown ranges. Later he began his long journey westward, following in general the usual pack trail from Santa Cruz to Cochabamba but often diverging to south and north.

From Cochabamba the exploration and survey of the high plateaus and upper valleys to the northwest were carried out, and later similar work was done in the Cordillera de Quimsa Cruz—the part of the Cordillera Real south of the Rio de La Paz; but unfortunately these surveys were not connected.

The book now published, after an introductory account of the expeditions and a bibliography of 91 entries, opens with a chapter on the physical geography of Bolivia. The section of this which deals with the orography and hydrography is probably the most accurate brief statement that has yet appeared regarding the Andes east of the meridian of Oruro. The author commits himself to a statement of the climatic conditions with great diffidence, pointing out the almost complete absence of reliable observations; but he has rightly decided to include a brief treatment of climate in its broader aspects.

The main portion of the work is divided as follows: a brief description of some features of the leading plants represented in the country, treated by natural orders, with mention of their position in localities and in plant formations (36 pp.); a summary of the vegetation types by regions and formations (5 pp.); a description of the natural vegetation, region by region, including discussion of the floristic compositions and their probable genesis (151 pp.), followed by three pages on the plants in the service of man. The work concludes with a list of endemic plants and two indexes. It is illustrated by excellent photographs, by four diagrammatic profiles showing the altitudinal distribution of formations, and by two maps. The first of these shows the floral provinces and extension of key genera and species between latitudes 9° and 26° S. and from central Peru eastward to beyond the Rio Paraguay; the second, which is of larger scale (*c.* 1:2,250,000), is a vegetation map showing the distribution of the ten leading formations from the Bolivian Altiplano eastward to the plains and between latitudes *c.* 16° 30′ and 19°.

The parts of Bolivia studied by the author are divided from the vegetation standpoint as follows:

(a) The Puna of the Altiplano—Tola heath with yareta in the drier parts, vegetation thinning southward and salt desert increasing.

(b) Zone of the eastern summits—Alpine grassland, semi-xerophytic on the inner side, mesophytic on the outer, near snow line cushion and rosette-like plants.

(c) Eastern basins, including a huge area of plateau and valley within the bend of the Rio Grande reaching northward nearly to the limit of its drainage and transgressing this to include the head valleys of the Yapacari—cactus and thorn bush with thin xerophytic woodland.

(d) Northeastern slopes of the Andes (north of 18° S.)—*montaña* rain forest, subdivided into (1) lower (*yungas*) up to *c.* 1500 meters, characterized by palms; (2) middle *yungas* to *c.* 2400 or 2800 meters, characterized by cinchona, tree ferns, coca, and coffee cultivation; (3) cloud forest (*ceja de la montaña*) to 3400 meters, characterized by ericas, myrtaceae, and epiphytes, especially mosses and ferns. This is essentially the same as the formation in Peru and western Bolivia described by Weberbauer and others. The altitudinal limits are described as varying, being higher on high ridges and lower where summits are lower.

(e) Eastern marginal cordilleras (18°–25° S.)—deciduous forest, green in the (summer) rainy season; palms absent.

(f) Piedmont north of 18° S.—savana, consisting of macrotherm and partly xerophytic forests separated by grassland.

(g) Gran Chaco—alternation of *monte* composed of succulents and thorn bush, grassland, algarrobo (*Prosopis*) woods, and palm (*Copernicia*) groves. This is in character allied to (c), and it is incompletely separated from (e).

Geologists, physiographers, botanists, and zoölogists are fast amassing evidence bearing upon the life history of the Andes as a mountain system. Herzog's contribu-

tion seems to be a large one. It rests upon his analyses of the flora and his conclusion regarding the sources from which it has been derived. It is for botanists to judge whether the evidence justifies these conclusions. But whether the conclusions are the right ones or not, the evidence remains to be dealt with in relation to the data of geologists and of other biologists. Without attempting to follow here the author's arguments in regard to the flora, it may be useful to summarize his conclusions.

The Altiplano and still higher plateaus and mountain slopes of the Central Andes are occupied by a flora composed of Andean genera commingled with others of Boreal and Austral-Antarctic origin; the proportions given in a list of leading genera being respectively 9:7:2. The proportion of Boreal types is highest in the mesophytic grass formation on the eastern (moister) slopes above the tree line. This composition is explained by the well-grounded hypothesis that, at least for a long period following the maximum glaciation, the high cordilleras served as a cold bridge, along which plants spread toward and beyond the equator from far north and far south. It seems likely that some of the endemic Andean plants are derived from ancestors which inhabited the older pre-Andean surfaces of lower altitude.

The mountains and valleys below the Altiplano level apart from the well-watered front ranges are occupied by a xerophytic flora made up of general Neotropical elements together with a large assortment of purely Andean plants which bear a strong resemblance to the Mexican flora. This kinship with the north is one of the striking facts of plant geography. The author considers the evidence of existing continuity from the Ecuadorian Andes through Central America to Mexico as insufficient, and prefers to regard the florae as once continuous but now severed by climatic—and presumably tectonic—causes. The main area of this, the Valles flora of others and here called the Inter-Andean xerotherm flora, lies east of the southern Altiplano in the drainage basins of the Rios Grande, Pilcomayo, and Bermejo.

The Sub-Andean flora of the *montaña* forest is to be regarded as "unitary" from the Northern Andes to 18°S. The Bolivian part of it is made up primarily of endemic plants but contains elements from three other floral provinces, the proportion being in the following order: (1) Central Brazilian, (2) Equatorial Brazilian, including Guiana and the West Indies, (3) Austral-Antarctic.

In discussing the flora of the forests (including the *montaña* above mentioned) on the outer northeastern and eastern slopes of the Andes, the author likens the bend in the ranges about latitude 18° S. to a great headland projecting into an ocean. Towards this there came a steady stream of species from the plant reservoir on the ancient land mass of the central Brazil highlands, which here approaches most nearly to the Andes, a projection—the sandstone ridges of Chiquitos—offering a bridge, early emerged, to give westward passage to the plant life. This vegetable stream, striking the Andean headland, divided; and Brazilian genera have spread northwestward, commingling with the Sub-Andean flora of the *montaña*, and southward to form the preponderating element in the marginal Sub-Tropical forests of the eastern cordillera. On the mountain slopes southwest of Santa Cruz the Brazilian and Sub-Andean elements are in equilibrium.

The Hylaea (evergreen rain forest of Amazonia) is not discussed separately in this work, but elements from this formation are described as tongues projecting southward along the main rivers into the other formations, and merging into the *montaña*. The piedmont and plains about Santa Cruz exhibit great variety floristically as well as in their vegetation. The trees and bushes of the savana are mainly Central Brazilian; plants from southern Brazil and northern Argentina dominate the grassland; while the presence of *algarrobo* and *chañar* trees points to a migration from the southern Chaco.

One of the most interesting conclusions arrived at is that the vegetation of the Gran Chaco is in the main composed of elements derived from the xerotherm flora of the lower Andean plateaus and valleys, and this in spite of an intervening zone

of Sub-Tropical forest, whose chief origin is Central Brazil (as mentioned above). Yet it is less surprising when the climate of the two regions is remembered, for conditions of rainfall are essentially similar. The Chaco plains became dry land long after the eastern Andes, and it is clear, therefore, that the parent flora must be that of the mountains and not that of the Chaco itself. The author, while pointing out how little of the Chaco is known, yet finds sufficient evidence that Andean genera predominate; and so we may accept virtual Andean origin for these well-nigh impenetrable expanses of woodland and *monte* brush, as we do for the soil upon which they grow.

A. G. Ogilvie

South American Timber

S. J. Record and C. D. Mell. **Timbers of Tropical America.** xviii and 610 pp.; ills., index. Yale University Press, New Haven; Humphrey Milford, Oxford University Press, London. 1924. $10.00. 10 x 7 inches.

The second part of this valuable report, entitled "The Trees and Their Woods," by the senior author, and consisting of nearly five hundred pages, is a distinct contribution to our knowledge of the timbers of tropical America. It is admittedly not the last word on the subject but ought to do much to stimulate efforts to obtain material for further research.

Unlike the great majority of works on the subject this report has had for its basis first-hand knowledge of a collection of woods comprising some seven thousand numbers (some with authentic botanical material obtained from the same tree) that has been deposited in the working museum of the Yale School of Forestry.

In arrangement, the treatment of the woods is by natural orders, or families. This includes a brief description of the wood characters of the family as a whole, followed by a more detailed treatment of the principal woods that belong to them. After a discussion of the commercial importance of the woods, sometimes with historical references, there are semi-technical descriptions of some one or more specific woods that belong to the groups and long lists of commercial and local names under which the woods are known in the various regions in which they occur.

These lists are valuable also because they show the geographical range of the different species or groups of species. Thus, it is pointed out that mahogany, known locally as caoba, consists of not one, as is generally believed, but of five known species and that this group is confined to the northwestern section of tropical America, viz. the West Indies, southern Mexico, Central America, and, in South America to Colombia, Venezuela, and perhaps Ecuador. On the other hand, the Spanish-cedar group, known locally as cedro, consisting of more than thirty species, is found in every political unit from the West Indies and Mexico to and including Argentina.

The first part of the report, entitled "The Countries and Their Forests," by the junior author, and comprising eighty pages, is intended as a setting for the second part. While it has many good points, much of importance is lacking.

Considerable space is devoted to the physical features of each of the political units, much of which could have been better expressed by maps; but in many instances one does not get a good idea of the distribution or character of the forests.

There are indications that the author depended too much on his personal impressions and not enough on the literature of the subject. Thus, in speaking of the coastal region of Brazil, he states that "mangrove skirts the coast . . . covering vast (*sic*) areas in the north and also in São Paulo" (p. 73). On the same page there is an overemphasis of the extent of the savana areas; and again, still referring to the coastal region, the author says, "That portion of the belt from Bahia to Uru-

guay includes the true agricultural land of Brazil . . . The region as a whole includes the present commercial and economic forests of Brazil" (pp. 73-74). By these two statements the author seems to exclude the Brazilian highlands, where the present agricultural wealth is located and where the only large-scale logging in all tropical America is being conducted.

As a matter of fact there are three economically important forested regions in Brazil.

1. The Amazon region, which the author disparages and states is not at the present time commercially important, is not only the largest area in hardwood forests in Brazil but in the world. Although the cut of timber here at present is comparatively small, the Amazon region is exporting more timber than the coastal region, and some of its lumber reaches this latter region. If rubber, Brazil nuts, and palm nuts are included with lumber, more forest wealth is being produced in the Amazon than in the coastal region.

2. The forests of the highlands, especially those from São Paulo south to and including the northern part of Rio Grande do Sul, contain hardwood and mixed coniferous and hardwood forests. It is in the latter that the largest lumbering operations are being carried on. The highlands not only furnish most of the timber used by this important agricultural district but send considerable quantities to the coastal region; comparatively large amounts also are exported, mainly to Uruguay and Argentina. No other lumber region in South America is so important as this at the present time.

3. The hardwood forests of the coastal belt have been badly cut over for agricultural purposes. While the amount of hardwood lumber being cut here is in excess of that exploited in each of the other two regions, at the present time this is barely sufficient, because of the crude system of logging in practice, to meet the local demand for it. With the introduction of more modern lumbering methods, the output could possibly be raised to such an extent that there would be large quantities for export.

H. N. Whitford

Life in Scandinavian Lands

Gustav Braun. **Die nordischen Staaten: Norwegen, Schweden, Finnland: Eine soziologische Länderkunde.** 138 pp.; maps, ills., bibliogr. Ferdinand Hirt, Breslau, 1924. 9½ x 6½ inches.

An excellent little book of the traditional German character for regional geography, but an astonishing failure to apply the plan proposed in three pages of introduction and conclusion.

It gives a good description from geology to occupations and history of the people, with more than usual reference to possible human interests. The language is clear and the matter interesting. There are 45 admirable half-tones. Some things omitted might be lamented but for the fact that a second volume is to come, either as a whole or in parts for each country. This second volume is to dissect the countries into economic units and study these units in action.

The plan which the author proposes in his introduction, *but utterly fails to carry out*, was to make a country's exported and imported wares the threads that he would trace back to the life of the people and the nature of the land environing them. For 70 of his 106 pages you get no statement even of exports and imports. The table at page 70 is utterly crude and undigested. In the first place it is for 1913. Some apology may be made for that, but Dr. Braun does not make it. To illustrate its indigestibility: Norway exports 132 million kroners' worth of "food of animal origin." You can infer from some of the comments that part of this is cattle products and part of it fish, but not *what* parts.

The admirable volume "Norway," published by the Government in 1900 for the Paris exhibition, gave the needed data, which Dr. Braun could undoubtedly get today; namely that in 1898 the exports of fish were of value 45 million kroner, of fish in tins 1 million, of butter and margarine 3.6 million, of condensed milk 4.6 million. There you have matters set out in true proportion, and most interesting threads might be traced back to the people in their homes. In western Norway the cattle in those days were sent up to the mountain *saeters* as long as the pastures there were free of snow, while down below every possible blade of grass was harvested and stored away, together with the tops of the potato plants and the tips of the young birches, as cattle feed for the long winter. The farmers trimmed the grass around rocks and trees with their little sickles as carefully as the barber trims your hair. Grass was obviously precious. You are not surprised to learn that no poultry was kept—hens scratch up so much grass! So the eggs consumed in western Norway were "made in Germany."

It is to be hoped that Dr. Braun will follow his proposed plan in the volume to come.

MARK JEFFERSON

A Swedish School Atlas

ALFRED SÖDERLUND, edit. **Svensk Skolatlas, I: För Folkskolan.** 16 pp. of maps. Skriv-och Ritboksaktiebolaget, Stockholm, 1924. 12 x 9 inches.

Swedish art and Swedish geography alike should be crowned with laurels for this little elementary school atlas of a dozen principal maps and a dozen minor ones.

Beautiful colors, marvelous offset-printing with its perfection of color registration, clear delicate outlines, scholarly selection of details, and the use of fresh, new methods characterize the book.

I should call the beauty of the maps its first "feature." The second is the representation of all large cities by the self-explaining size symbols—spheres—that Sten De Geer has made familiar in his great map of distribution of people in Sweden (see *Geogr. Rev.*, Vol. 12, 1922, pp. 72–83) and Söderlund has also used in his similar map of Norway (reviewed in *Geogr. Rev.*, Vol. 14, 1924, pp. 646–647). These spheres of solid contents proportional to the size of the city fix on the observer's mind an inescapable impression of the dominance of New York in North America, of London in Britain, though they show duly the importance of Chicago and Glasgow, of Paris in France, and the coequal size of Madrid and Barcelona in divided Spain. The third feature is the set of little continent maps of products in pleasing tints and a clearly elastic legend.

Söderlund and his coworkers do not fail to utilize modern advances in knowledge, for instance upwelling waters where we used to represent cold currents in the "Labrador Current," "California Current," and "Humboldt Current," on the hemispheres map. Railroads are marked on all maps but the hemispheres. All the maps are political but have an expression of relief at once simple and excellent. Five continents have the same scale, 1:40,000,000, with Europe double size.

The American eye is not much pleased with the strong black lettering of country names, almost as strong as on French school maps. But the pedagogy is doubtless sound. Children are to have those names fixed by seeing, and they must make no effort to see!

The black names are utilized to distinguish independent countries. Africa shows them only in Egypt, Abyssinia, South African Union, and Morocco. Algeria lacks the bold vivid name. So do India, Java, and British Guiana.

As far as I know this is the best school atlas produced anywhere.

MARK JEFFERSON

The Story of Lake Ragunda

H. W. Ahlmann, C. C. Caldenius, and R. Sandegren. **Ragundasjön en geomorfologisk, geokronologisk, växtgeografisk undersökning.** viii and 119 and 91 and 55 pp.; maps, diagrs., ills., bibliogrs. In Swedish with German résumé. *Sveriges Geol. Undersökning*, Ser. Ca, No. 12, 1924, Stockholm. 12½ x 9½ inches.

Ahlmann's and Sandegren's papers were originally printed in 1915, but almost the entire editions were destroyed by fire in 1922. When Caldenius' part was completed in 1924, Ahlmann's paper was reprinted practically unchanged, Sandegren's paper after revision.

Lake Ragunda was situated in the valley of the Indalsälven River in northern Sweden (63° N.). It was catastrophically drained in 1796, and its deposits were deeply trenched when its waters were directed across the partly excavated drift barrier blocking the pre-glacial river channel.

Ahlmann treats the whole geomorphological history of the lake and the development of the region after the drainage, giving detailed descriptions of the conditions at successive stages.

Caldenius treats the clastic deposits and their records. During the uncovering from the last ice sheet, outwash and varved glacial clay were deposited in the lake basin. Later, delta sediments and varved post-glacial clay silts were laid down. Part of the finest material went through the lake. The varve curves show good agreement with each other; but it has not been possible entirely to eliminate local influences and thus to obtain a curve of the relative annual snowfall.

Sandegren undertook a stratigraphic and chronologic investigation of the plant remains in the lake deposits, whose layers are dated almost exactly in relation to the bisection of the ice rest and with very fair accuracy in relation to the Christian chronology, Gerard De Geer having recently succeeded in connecting the Ragunda chronology with Ragnar Lidén's post-glacial chronology in the valley of the Ångermanälven. Sandegren's study of the evolution of the climate of the region is unrivaled in accuracy. Plant remains are plentiful. The most important fossil localities occur in the central parts of the ancient lake. The remains consist of wood, bark, cones, leaves, fruits, seeds, etc. Leaves of deciduous trees densely packed at places form layers resembling cardboard.

The geological history of the region is shortly as follows. When the ice sheet withdrew from the district the present valley formed a deep and wide fiord of the Baltic, which registered a shore line now lying about 240 meters (787 feet) above sea level. In this fiord at first glacial varve clay, later post-glacial varved clay silt were deposited. The oldest plant remains, representing *Betula odorata*, *Pinus silvestris*, *Populus tremula*, and *Alnus incana*, occur in varves 620 to 630 after the bisection of the ice rest. Rising of the land progressed, and about varve 800 the lake became isolated from the Baltic by a barrier of glacial drift. In varves 1230 to 1240 there appears a flora of the same temperate character as that nowadays found in the region. *Ulmus montana* and *Stachys silvatica* may be especially mentioned. About varve 1300 Lake Ragunda was isolated by a rock sill. During the time 1780 to 2730 there existed in the region a rich flora indicative of higher summer temperature than prevails today. Already at this time or during the Atlantic period, that is about 7000 to 6000 years ago, the post-glacial temperature maximum was reached. Then the following plants, whose present northern limit of distribution lies farther south, flourished in the region: *Carex pseudo-cyperus*, *Corylus avellana*, *Lycopus europaeus*, *Solanum dulcamara*, *Stachys silvatica*, and *Ulmus montana*. About year 3700 Lake Ragunda was saturated with sediments, and the Indalsälven became localized to a trenched channel in the deposits. This evidently marks the end of the Ragunda chronology. Shortly after a drought period set in, and the high-water

level of the lake, previously regulated by a rock ledge, sank probably about two meters (6.5 feet). This is shown by occurrences of peat bogs in depressions within the former lake area and by the sequence of strata of these bogs. Subsequently, in connection with an increase in precipitation and fall of temperature, the lake again rose to above the rock ledge, and the warm-climate flora retired southward. The drought period is the sub-boreal period, and the preceding and following moist periods are the Atlantic and sub-Atlantic periods respectively.

ERNST ANTEVS

THE NEW EDITION OF DE MARTONNE'S PHYSICAL GEOGRAPHY

EMMANUEL DE MARTONNE. **Traité de géographie physique.** 4th edit. **Vol. 1: Notions générales, climat, hydrographie.** xi and 496 pp.; maps, diagrs., ills., bibliogrs. Librairie Armand Colin, Paris, 1925. 10 x 6½ inches.

It is a high privilege to review a good book. Professor de Martonne's "Traité" was a distinctive and scholarly work in its first edition; and by three successive revisions, the last the most thorough of all, he has made it perhaps the most useful work of reference in physical geography in any language. To those familiar with the organization of similar works in America it is necessary to point out that while types of climate, lakes, rivers, seas, etc., are discussed in de Martonne's book, the richness of the text is chiefly due to the effective use of the principle of comparison. This is not the result of accident but of design. In the first chapter is an admirable expression of modern geographical doctrine, and it is worth special attention because the author has really put his philosophy into effect. He states (p. 24) that geography has a character which is essentially scientific and philosophical but that there are also realistic and descriptive qualities, and it is only in the combination of all four that we have geography as a distinctive modern science. He considers that there are three essential principles of geographical method: (1) distribution or extension, (2) comparison, or what we might call sorting or classification, and (3) the explanations of things. Geography, in his view, is the only science that studies the distribution of phenomena of the surface of the earth and that links them to general laws whose effects are then sought elsewhere. The combinations of local or regional influences have to be known in a manner in which the physicist, the botanist, and the statistician do not know them. That is the geographer concerns himself with the surface of the earth as a great laboratory where a surprising variety of regional types are found. With the characteristics and courses of these types the geographer is chiefly concerned. He is not interested in distribution as such, nor with the distribution of all things, but with distributions that point the way to general laws that affect man and his activities.

In the first part of the fourth edition (the only part yet published) the major space is given to a section on climate. In fact, this section makes a considerable handbook in itself, and, while it does not have the originality displayed in the sections dealing with land forms (as treated in previous editions), it is eminently satisfactory as a well-balanced treatise from which there has been removed every unnecessary paragraph and sentence, thus giving an effect of close organization and what one might call high speed to the clear, well-balanced discussions of successive phenomena and climatic types. The two maps at the end of the volume represent thorough revision as compared with those in the three preceding editions. In the world map showing the relief of the lands and of the sea floor the latest topographical surveys have been embodied in most instances. Similar care has been exercised in the revision of the climatic map. Both maps are in color. The climatic map has a fundamental change in terminology besides a reduction from twenty-seven to twenty-six general types. The effect is one of great improvement since in general

the local names that formerly designated types have been displaced by broader regional names. For example, the Ukrainian type of climate of the earlier editions becomes a "steppe variety," and the Polish climate becomes "continental." It is important to emphasize these changes because the present edition should be purchased by everyone interested at all in referring to de Martonne's method of treatment or to the facts and principles of geographical science. There has been a fifteen to twenty per cent increase in the number of bibliographical references. The number of figures in Part I has been increased from one hundred and sixty-five to one hundred and ninety-three as between the third and fourth editions. Upon both the large colored maps at the end of the volume as well as upon a number in the text, but particularly Figure 153, it is hard to understand why the northeastern corner of Greenland has not been completed on the basis of the topographic work of the Mylius-Erichsen Expedition. We point out the omission only because it is one of the important major additions to cartographic knowledge since the appearance of de Martonne's first edition. In one of the divisions of the climatic bibliography are thirty-six items on climate of which ten relate to local winds, such as chinook and valley winds, though there is no mention of W. M. Davis' standard work on the sea breeze. In the list of references on water, King, 1899, is mentioned, but not Slichter, whose "Motions of Underground Waters" (*U. S. Geol. Survey Water Supply and Irrigation Paper No. 67*) is now a standard book. The reviewer can find no reference to M. F. Maury's classic "The Physical Geography of the Sea" (1855). In any general discussion of ocean currents and the atmosphere there ought to be some reference to Benjamin Franklin, just as the section on cyclonic storms ought to bear the name of the most original contributor to the subject: William Ferrel, "A Popular Treatise on the Winds" (1889). No doubt these few suggestions have been considered by the author and have been rejected for good reason. They merely express the reviewer's judgment that a general book like de Martonne's should include them, especially a book so broad and thorough in its treatment and so truly international in its dependence upon references to the leading languages of science.

Weather Notes for the General Reader

C. F. Brooks. **Why the Weather**? With the Collaboration of John Nelson and Others. xvi and 310 pp.; diagrs., ills., index. Harcourt, Brace & Co., Inc., New York, 1924. 7½ x 5 inches.

Popularized science, Dr. Brooks calls it, for general readers who want to know more about the weather. Very bright and taking it is, offering a wealth of interest on weather matters. Witness the fresh and vigorous account of boiling temperatures in Bolivia, the vivid portrayal of the ice storm of November, 1921, in New England, not to mention the delightful test of likelihood of summer thunderstorms according as the relative humidity is over 70° (likely) or under 60° (unlikely), if it may be trusted, and all the details of actual weather of 1923, elucidated by parallels from earlier records. Dr. Brooks is admirably informed of the weather happenings of this country, and the book is limited to that. A man need not be ignorant of the weather and its science to find the book useful.

The explanations read easily. The whole book does that. Dr. Brook's note of certitude helps. He tells exactly what happens to a hailstone throughout its history, where a writer like W. M. Davis contents himself with stating what the circumstances suggest for its origin, which is a less popular method.

The reviewer is free to confess that he has not the omniscience proper to a reviewer, and that meteorology has for him a charming collection of unsolved problems. None of these, however, does Dr. Brooks happen to solve in this book.

The explanation of lightning at page 130 looked promising but did not prove very convincing, nor is there in the book any reference by which to refer to "Lenard" for the fuller argument.

Incompleteness of explanation and looseness of language are characteristic of too great a part of the book for entire clarity. Possibly perfect clarity was not aimed at. Perhaps the aim was rather a treatment suggestive of the causes at work. Possibly Dr. Brooks does not care much for precision of language. At any rate water vapor in the air he refers to indiscriminately as water vapor, water, or moisture (pp. 22 and 23) exactly as the "ordinary reader" would; but that is a loose way of talking, and I think the popular value would not be hurt by sticking to the precise name water vapor when that is what is meant. Incompleteness of statement is noted in the author's story of Quervain's ingenious use of a black bag which he filled with snow and hung on his sledge in the sun as he crossed the Greenland ice cap, thus getting drinking water at all times even when the temperature was well below freezing. The explanation lacking is some account of the difficulty experienced by previous explorers in getting drinking water on the same ice cap. Nansen gave a vivid account of it, I think—nothing but snow at freezing temperatures and much thirst, which could only be satisfied by halting and setting up a tent as shelter from the wind and lighting a lamp to melt enough snow for a drink. This was so much trouble that the travelers were always thirsty, and when the border of the inland ice was reached and running water was met, every one rushed to it and flung himself down on his face to drink.

The explanation of asphalt mirage (p. 108) is incomplete and loosely worded, "the refraction acting in effect as would a mirror." That is something refraction cannot do.

To pick out the true horizon where hills mask it (p. 151) by selecting a "point level with the eye" is not possible. Probably Dr. Brooks means to guess where the horizon is, the method being very rough. It is not true (p. 189) that "water flows down the slope, the air along it." Can it be meant that water runs so slowly in most cases that rotational deflection does not affect it very much, especially as it is usually entrenched between confining banks? Many of us have looked for deflection in the flow of streams on land, and the ocean currents are very generally supposed to be subject to it.

Is there some other account of Franklin's discovery that northeast storms come from the southwest than that contained in Franklin's letter of February 13, 1749–1750? Franklin does not tell the story as Brooks does. It is unfair to this very great American scientist to say (p. 180) "Franklin noted what may have seemed to him an anomaly: the northeaster always arrives from the southwest." We do not have to guess how it seemed to Franklin. He printed a clear account of his observations and his most acute reasoning from them a century and a half ago.

It would not have needed very much attention to have removed blemishes like these—all, I fancy, the result of carelessness—from a book that withal is likely to stimulate interest in meteorology more than any other book ever written.

Mark Jefferson

Sir Napier Shaw on Weather Forecasting

Napier Shaw. **Forecasting Weather.** 2nd edit., revised and enlarged. xliii and 584 pp.; maps, diagrs., ills., indexes. Constable & Co. Ltd., London, 1923. 36s. 8½ x 6 inches.

Sir Napier Shaw, throughout a long period of professional service, has been a busy man; and, although he has now withdrawn from the directorship of the Meteorological Office and other duties more or less official in character, he is still unmistakably busy, and his pen more productive than those of many of his juniors.

Somehow he has found time to give us a second edition of this work which first appeared in 1911. The many developments incident to the war made extended revision necessary. Forecasting weather suddenly in 1914 took its place as part and parcel of the great game. Sir Napier hints at this when he writes, "The few aeroplanes and airships which represented the national equipment of the Air Services of 1911 became multiplied into thousands of aeroplanes and a complete patrol of the British coasts by airships; innumerable kite-balloons with standard winches and other gear for manoeuvring them were at the service of those who wished to explore the upper air."

Yet in the book not much space is given to examples of the application of forecasts. There are three chapters, XV, XVI, and XVII, which treat of forecasts for aircraft, forecasts for air and sea, particularly visibility, and forecasts of land fogs; but otherwise the discussion is along academic lines treating the physical processes of weather.

Copies of the latest codes for transmission of weather reports are given, and, inasmuch as radio sets are quite general, it is now an easy matter for the laity to "listen in" and get not only the forecasts but the code messages used in making up the map. He laments with justice, we think, that the information now poured into the Daily Weather Report is so ample that it causes embarrassment. His humor comes out in the remark, "The situation which confronts us is that of a computer who is faced with the solution of a number of simultaneous equations. The calculation is quite an exhilarating exercise when the number of variables is two; it becomes rather tedious when a third variable joins with its equation; when there are ten any ordinary computer recoils from the task, and when there are twenty he seeks some other occupation."

Owing to new demands, specific information of hitherto unnoticed conditions must be obtained and distributed; and we have, as our author states, now reached a stage where seven or eight thousand entries are required for the full discussion of the weather of a single day. Unless this mass "is peptonised in some . . . way there is some danger of its causing indigestion." 'Tis well said. The weather map of the British Isles is a small affair compared with our American weather map, and some readjustment might well be made in the presentation of temperature and pressure data.

The book is written for British readers, and in consequence of this many of the maps will have but a passing interest for American readers. We can not very well ask the author to rewrite the treatise, but undeniably it would contribute much to an intelligent appreciation of aerography in this country if author and publishers could arrange in a third edition to extend the field by including a few memorable storms of the United States. True, we have an official treatise on forecasting, published eight years ago, and there is much meat in it; but a modern treatment of the subject is needed. We have some interesting developments of anticyclonic control in this country; and as for cyclones, we know them in their entirety—quite different from those of the British Isles, which, as Sir Napier says, "are hardly with us long enough to develop real personal acquaintance."

It is not easy to single out special chapters for commendation, where there is so much that deserves praise; but to those of us who have to explain to students the relations of pressure, temperature, humidity, and airflow, Chapter VIII (The Physical Processes of Weather) is particularly helpful. Sir Napier Shaw sets forth so clearly the processes of dynamical heating and cooling, that what in other hands too often is hard and dry reading becomes easy and most attractive. Fascinating perhaps is the right term to use, for, rightly interpreted and told, there is no story that can surpass in romantic interest this tale of the changes always in progress in the air around us.

Alexander McAdie

A Working Manual on Analysis and Prediction of Tides

Paul Schureman. **A Manual of the Harmonic Analysis and Prediction of Tides.** v and 416 pp.; diagrs., ills., index. *U. S. Coast and Geodetic Survey Special Publ. No. 98.* Washington, D. C., 1924. $1.00. 9 x 6 inches.

The advantages of specifying the tide at any place by means of harmonic constants are gradually becoming more widely recognized, while the superiority of the harmonic method for the prediction of tides is attested to by the fact that the tide tables issued in advance annually by the various maritime nations for the use of the navy and merchant marine, are being based more and more on the harmonic method. In this country the harmonic method is used altogether in the preparation of the tide tables issued by the government.

In the preface to his volume Mr. Schureman states that it was designed primarily as a working manual for tidal computers. It is divided into three parts. Part I, after an introductory section giving a brief historical statement and a general explanation of harmonic analysis and the equilibrium theory, deals with the tide-producing forces, the derivation of the various tide components, and the prediction of tides. In this part the processes for the harmonic analysis and prediction of tides are given in considerable detail, and attention is called to the applicability of the harmonic methods to tidal currents. It contains also a good description of the tide-predicting machine used in the preparation of the tide tables issued by the United States Government. Part II consists of forty tables for facilitating the analysis and prediction of tides. A number of the factors employed in the harmonic method vary from year to year, and in these tables Mr. Schureman gives the values for each year from 1850 to 2000. Part III lists the harmonic constants of the tide for some 800 places throughout the world.

The volume deals with a highly specialized process which is described in but few publications. In this country there has been no publication devoted to the harmonic method of tidal analysis since the appearance in 1898 of Part II of the "Manual of Tides" by the late R. A. Harris, and this has been out of print for some time. Students of tides will find Mr. Schureman's volume a very useful publication, the matter being presented clearly and with sufficient detail. They will find particularly useful the table of harmonic constants which lists the known harmonic constants for the entire world. Many of these have not heretofore been published, and for those that have been published the student was compelled to search through a number of scattered reports and memoirs.

H. A. Marmer

German Political Geography

Zeitschrift für Geopolitik. Edited by K. Haushofer. Monthly. Berlin-Grunewald. Vowinckel, 1924.

Karl Haushofer and Josef März. **Zur Geopolitik der Selbst-Bestimmung: Südostasiens Wiederaufstieg zur Selbstbestimmung; Das Schicksal überseeischer Wachstumsspitzen.** 503 pp.; bibliogr., index. Rösl & Co., Munich and Leipzig, 1923. 8½ x 5½ inches.

The Swedish scholar Rudolf Kjellén, who died in 1922, was one of the leading modern proponents of the theory of the state as a living, "biological" organism. The influence of his writings, particularly of the "Staten som Lifsform" (first published in 1916 and translated into German under the title "Der Staat als Lebensform," 4th edition, Berlin, 1924), has been felt particularly in Germany. Indeed, it might almost be said that a definite German school of politico-geographical theory founded upon Kjellén's work has sprung into being.

Geopolitik was the name applied by Kjellén to those particular aspects of geography and political science concerned with the relation of the state to its geo-

graphical environment. The founding of a monthly periodical in January, 1924, the *Zeitschrift für Geopolitik*, devoted exclusively to the cultivation of this subject, bears witness to the widespread interest which has been stirred by Kjellén's work. Professor Karl Haushofer of Munich, the editor, frankly announces that the aim of this journal is the encouragement of investigations along the lines mapped out by Ratzel and Kjellén. He defines *Geopolitik* as "the science of the political forms of life in their areal relations, in their relations to the earth's surface, and as influenced through historical movements." Nearly all the articles are informative and original, sections are devoted to "geopolitical" news and books reviews, and the text throughout is enlivened by outline maps and cartograms. The titles of some of the leading articles will give an idea of the subjects covered: "The Unity of the Monsoon Countries," "The Mediterranean Seas as Geopolitical Areas of Power," "The Rhine and Danube as Fashioners of States," "The Fundamentals of European Commerce," "The Japanese Earthquake and Its Political Results," "The Geopolitical Structure of Brazil," "The Treaty of Versailles and Political Geography."

A new-found belief in the sanctity of self-determination, which has recently made itself evident among German writers on political topics (see *Geogr. Rev.*, Vol. 14, 1924, p. 666), is also expressed in many of the articles in the *Zeitschrift für Geopolitik*. More notably, however, it forms the central theme of Haushofer's monograph on "The Reawakened Movement Toward Self-Determination in Southeastern Asia," which constitutes the first part of the volume referred to above (the second part being contributed by Professor Haushofer's pupil, Josef März). Here the editor of the *Zeitschrift* has set himself the task of analyzing comparatively and in their geographical relationships the various far-eastern movements toward self-determination. Through a geographical study of the sentiments prevailing in the Orient in favor of self-determination, of the varying aptitudes of the different Eastern peoples for its enjoyment, and of the varying degrees to which they actually possess or are deprived of it at the present time, Haushofer believes that he may arrive at positive conclusions bearing upon the grave problems confronting contemporary Germany. As a study of conditions in the East the essay is in many ways a constructive contribution to geography. The author's comparisons and analogies between the Far East and Central Europe, however, seem overdrawn. Haushofer regards the "monsoon lands," stretching from northern Japan to the western borders of India, as a climatic and anthropogeographic unit: he presents interesting, if evasive, generalizations upon the influences that geographical environment has presumably here brought to bear upon political consciousness and upon the inhabitants' capabilities of maintaining or achieving independence. He concludes, reasonably enough, that, however potent geographical forces may be in affecting the conditions of self-determination, the *will* to attain independence in the last analysis is of first importance.

CORRESPONDENCE

Submarine Topography off Monterey Bay

Cambridge, Mass.
November, 1924

To the Editor of the *Geographical Review:*

The *Review* for last April contained an account by C. R. Longwell of a fault map of California in which the submarine topography south of San Francisco is taken from a chart, No. 5194, published by the Hydrographic Office in 1923; and it is noted that a "canyon-like trough heading in Monterey Bay is represented as continuing oceanward to a depth of 12,000 feet." It is true that the chart shows the submarine contours at 100-fathom intervals turned in, some of them very sharply,

toward the middle of Monterey Bay down to the 2000-fathom level; but an examination of the original large-scale chart on which the individual soundings were plotted and the contours drawn makes me doubt whether the submerged canyon really exists. The soundings off that part of the coast were made by the recently perfected Sonic Depth Finder—an echo sounding apparatus—installed on the U. S. Cruisers *Hull* and *Corry;* the depth was determined at points about a mile apart on lines ten miles apart trending square out from the coast. Near the shore of the bay a number of earlier soundings, combined with those made by the above-named cruisers, define the occurrence of what seems to be a submerged valley of erosion with considerable accuracy down to depths of more than 500 fathoms; but farther offshore, where the in-turned contours from 1000 to 2000 fathoms lie between two lines of new soundings, there is only one earlier sounding in the included area of about 300 square miles: there the in-turning of the contour is truly enough permitted by the depths thus recorded, but many other contour patterns are also permitted; and the recorded depths do not suffice to determine which pattern is the correct one. Hence, until additional soundings are received, the deeper part of the canyon as now contoured should not be regarded as a demonstrated submarine feature.

Farther south, where the lines of soundings are only five miles apart, the contours are of course more trustworthy, and the revelation of the many and pronounced inequalities of the sea floor in that region is highly instructive. Yet even there the chart could be more safely used if the position of each sounding had been indicated by a dot; for it would then have been possible for each student of the chart to see for himself where the contour lines are well established by the lines of soundings and where they are unguided across the intervening five-mile belts. The chart as published gives the lines a uniform authenticity all along their courses and thus greatly lessens their value in critical investigations.

W. M. Davis

Hydrographic Office, Navy Department
Washington, November 26, 1924

To the Editor of the *Geographical Review:*

In appreciation of your invitation, issued at the instance of Professor W. M. Davis, to comment upon his note on the canyon-like trough heading in Monterey Bay, the accompanying copy of a portion of Hydrographic Office Chart No. 5194 has been prepared to indicate the bathymetrical data from which the configuration of the Monterey trough has been drawn.

The lines of soundings in the Monterey region by the U. S. S. *Corry* and the U. S. S. *Hull* are indicated by the straight lines drawn at right angles to the general trend of the submarine topography. The distance apart of the soundings on each of these lines was between one and two miles, and the bathymetrical contours shown on the chart have been drawn in conformity with the depths that were measured along these lines.

In addition to the lines of soundings by the *Corry* and the *Hull* were the two lines of deep-sea soundings on rhumb and great-circle courses from Monterey Bay toward the Hawaiian Islands, taken by the U. S. S. *Albatross* in 1891 and 1892 (see *52nd Congr., 1st Sess., Senate Exec. Doc. No. 153*, pp. 9 and 18).

Besides these, the abundant soundings shown along the coast line of Monterey Bay in Coast and Geodetic Survey Chart No. 5402 served for the delineation of the contours down to the depth of 1000 fathoms.

As partaking of the nature of confirmatory evidence concerning the Monterey trough, there have been gathered since the publication of Hydrographic Office

Chart No. 5194 in March, 1923, determinations by the U. S. S. *Corry* in running along a north-and-south line across the trough in September, 1924. These soundings are shown on the chart underlined.

The feature which, by Professor Davis' assertion, should not be regarded as demonstrated is that which is depicted within the area overlaid by dashes. Whatever may be the modification which future accessions to bathymetrical data may

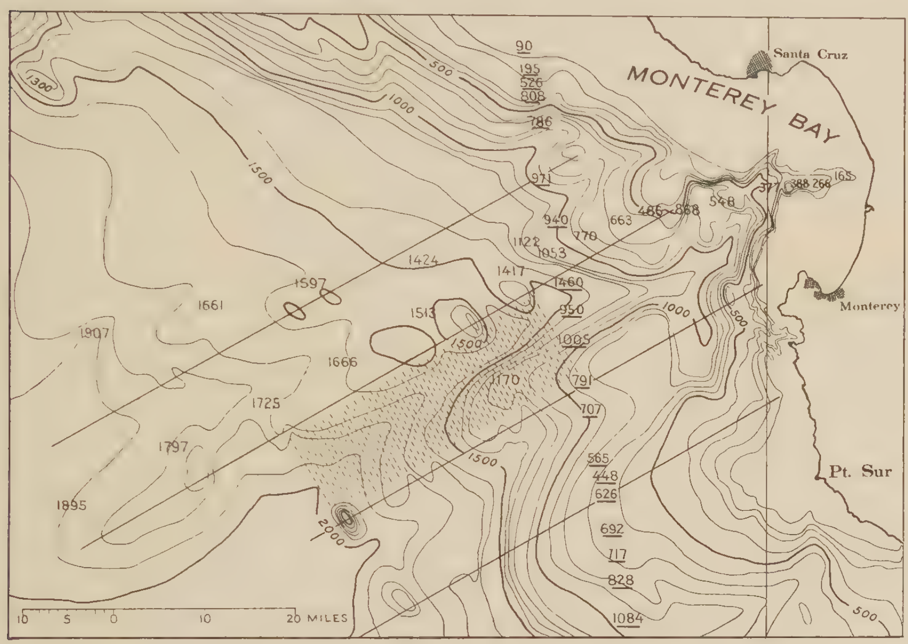

FIG. 1—Reproduction on a reduced scale of a portion of Hydrographic Office Chart No. 5194. The data mentioned in Captain Bassett's letter and a scale of miles have been added.

impose upon this part of the delineation, it would not seem to impugn the evidence of the existence of the submerged canyon to which ingress lies open by ascending gradations from the incurved contour of 2000 fathoms on a course to the northward and westward of the hatched tract containing the contours of configuration in relation to which doubt has been expressed.

F. B. BASSETT
Hydrographer

THE ISLE OF PINES

Dr. Thomas Barbour, of the Museum of Comparative Zoölogy, Cambridge, Mass., sends us the following comment on the Isle of Pines (see the note in the January *Geographical Review*, p. 137):

"The southern region is of uplifted eolian limestone, much eroded. Here at several points are small bays and the only deep water anchorages near the island, all of the other coasts being accessible to small boats only, on account of the extensive flats and shoals. In general this region remains little known. North of the great swamp in the southern portion of the island a considerable area of land has been cleared and devoted to citrus crops by American colonists with conspicuous lack of success, and great sums of money have been lost in these ventures. Many of

the plantations are now abandoned and reverting to wild lands. A few Americans continue to visit the island on account of its fine climate, most of the other regular visitors being the promoters of schemes for selling or reselling the so-called citrus fruit lands. It is possible to grow citrus fruit where there is sand, provided sufficient fertilizer is obtainable, but the marketing of the crop is both difficult and precarious. Large areas of the northern and central parts of the island are composed of the so-called savana lands formed of disintegrated igneous rock, supporting a few spindly palmettos, a little bunch grass, and a few indigenous shrubs. This vegetation will not support any grazing animal."

Dr. Barbour has visited the Isle of Pines collecting and on intelligence work frequently over a period of many years.

The Isle of Pines Treaty by which the United States relinquishes all claim of title to the island in favor of the Republic of Cuba was ratified on March 13, 1925.

The Automobile in the Sahara

Boston, Mass., January 29, 1925

To the Editor of the *Geographical Review:*

I have just read with great pleasure Mr. Gautier's article on "The Trans-Saharan Railway." Last winter my wife and I made the trip by automobile from Tozeur to Tuggurt and from Tuggurt to Ghardaia.

The Compagnie Generale Transatlantique were running a fairly regular service between Tozeur and Tuggurt, spending the night at El Wad. The Citroën Company, I was informed by the local French authorities, ran a car once every two weeks between the two points.

With regard to speed, the Renaud six-wheel cars, which are really twelve-wheel cars as each of the three axles carries four ordinary wheels on it, make in the sandy desert not over twelve or fifteen kilometers an hour. On the hard desert between Wargla and Tuggurt and Wargla and Ghardaia they could not make above twenty to twenty-five kilometers. I timed them for myself, and during the last part of the Wargla to Ghardaia journey we were driving against time.

As far as I could discover, for desert work there was not much choice between the Citroën and the Renaud cars; both of them would navigate sand into which a man would sink above his ankles perfectly easily and would take grades of at least 30°. The caterpillar cars I was told could not compare in speed over the hard desert with the Renaud cars. In the sand the speed of both of them was about the same. Even with automobiles five hundred kilometers of hard desert without a drop of water or a blade of grass is a very hard test.

There can be no question that the automobile can go anywhere in the Sahara, given a supply of water and a supply of gasoline at fixed points, and it can do the work much quicker than the camels can, but it is necessarily tied down by the requirements of water and gasoline.

Yours truly,
Ellerton James

THE
GEOGRAPHICAL REVIEW

Vol. XV | July, 1925 | No. 3

AN EXPEDITION TO THE LAGUNA COLORADA, SOUTHERN BOLIVIA

WITH A NOTE ON THE RECENT OCCURRENCE OF "EL NIÑO"

By Frederic C. Walcott

In January, 1921, Walter Perkins of the Chile Exploration Company reported the finding of a large lake of brick-red water in the center of the desert of southern Bolivia. It was in consequence of this report received by the American Museum of Natural History that the writer undertook a journey thither, specifically for study of the bird life of the region.[1]

The first step was to secure Perkins. This did not prove difficult. He had been prospecting and exploring in the region for a dozen years and welcomed the opportunity of a second visit to the lake. He made the trip not only possible but comparatively easy with his trained mules thoroughly hardened to high altitudes and the best Indians imaginable for the work. But the Bolivian desert is not to be entered upon lightly nor inadvisedly—rather in the fear of God and soberly, with ample food and water for both man and beast, a well-trained heart, and colored glasses and a heavy poncho ready against the terrific storms of the Puna.

The Ascent of the Western Cordillera

The starting point was Chuquicamata, the mining camp of the Chile Copper Company at an elevation of nearly 9000 feet. Here I spent some days in training for the high altitudes. From Chuquicamata the Western Cordillera is seen so plainly that its great peaks rising to 20,000 feet above sea level seem scarcely 30 or 40 miles away, whereas in reality they are twice this distance and more. In a bow-like line they stretch northwest and south, their snow-covered summits contrasting with the intervening

[1] At the instigation of Dr. F. M. Chapman of the American Museum of Natural History, whose work on the life zones of northern South America is well known and who is now engaged on similar study in the southern region.

FIG. 1—The Laguna Colorada. Looking across the northern end of the lake.

desert of lower and absolutely barren mountains and pampas in all shades of red, maroon, yellow, purple, and brown.

On January 30, 1924, we left Chuquicamata by automobile for Calama, 20 miles away on the Antofagasta and Bolivia railway whence we took train to San Pedro, altitude 10,570 feet, at the foot of the double volcano, San Pedro and San Pablo, the former peak active and always smoking. The mules were packed, and we set off over the great lava flows at the base of the mountain. Some 16 miles on we found a spring, Ojos de San Pedro, and a couple of forlorn-looking Indians living in a stone hut where we spent the night. The next day we made about 22 miles, gradually ascending between lofty mountains until we reached a single house by a small stream in a deep canyon. The stream is the Siloli, one of the four sources by which the railway supplies the stations along its line to Antofagasta, 250 miles away, and the nitrate oficinas adjacent.[2] The canyon is cut down 1000 feet below the surface of the desert in a maroon-colored volcanic rock, as picturesque a place as one could find anywhere. Our aneroid gave the altitude as 13,780 feet. The owner of the stone hut gave us accommodations for the night; his wife came in later. I remembered seeing her the day before, a squatty figure on a small burro jogging along the pampa with her father to the festival of the llama. It was being celebrated at Ayaviri, about 12 miles away at the house of an Indian who packed *llareta*, a fibrous moss used as fuel, into San Pedro for Chuquicamata. Probably these three made up the entire company. We saw no one else all day, and that was the only house, except the one where we spent the preceding night, for 40 miles. But the llamas must be decorated, the beast of burden honored by the tying of a few pieces of colored cloth and paper into its wool and the drinking of some pure alcohol mixed with a few drops of water. There is another annual festival, the *fiesta de choclo*, or corn festival at which large numbers of the Puna Indians foregather from great distances. Corn is so scarce a commodity and so much prized that the harvest of a few ears, each about as large as a goose's egg, brings forth general rejoicing and complete license.

Siloli lies approximately on the international boundary line between Chile and Bolivia. The house was the last human habitation we saw until we reëntered Chile. Even at this altitude the sun was blazing, the temperature about 70° F., and the wind still moderate; but already there were clouds over the divide.

The Laguna Colorada Basin

We now entered the great mountain-girt basin that holds the Laguna Colorada. It is part of the northern portion of the Puna de Atacama, "the

[2] For an interesting account of what is "probably the highest intake of any waterworks undertaking in the world" see R. H. Fox: The Waterworks Department of the Antofagasta (Chili) & Bolivia Railway Company, *South African Journ. of Sci.*, Vol. 19, 1922, pp. 120–131. The figure for altitude of Siloli intake is given as 14,154 feet, considerably higher than our aneroid reading.

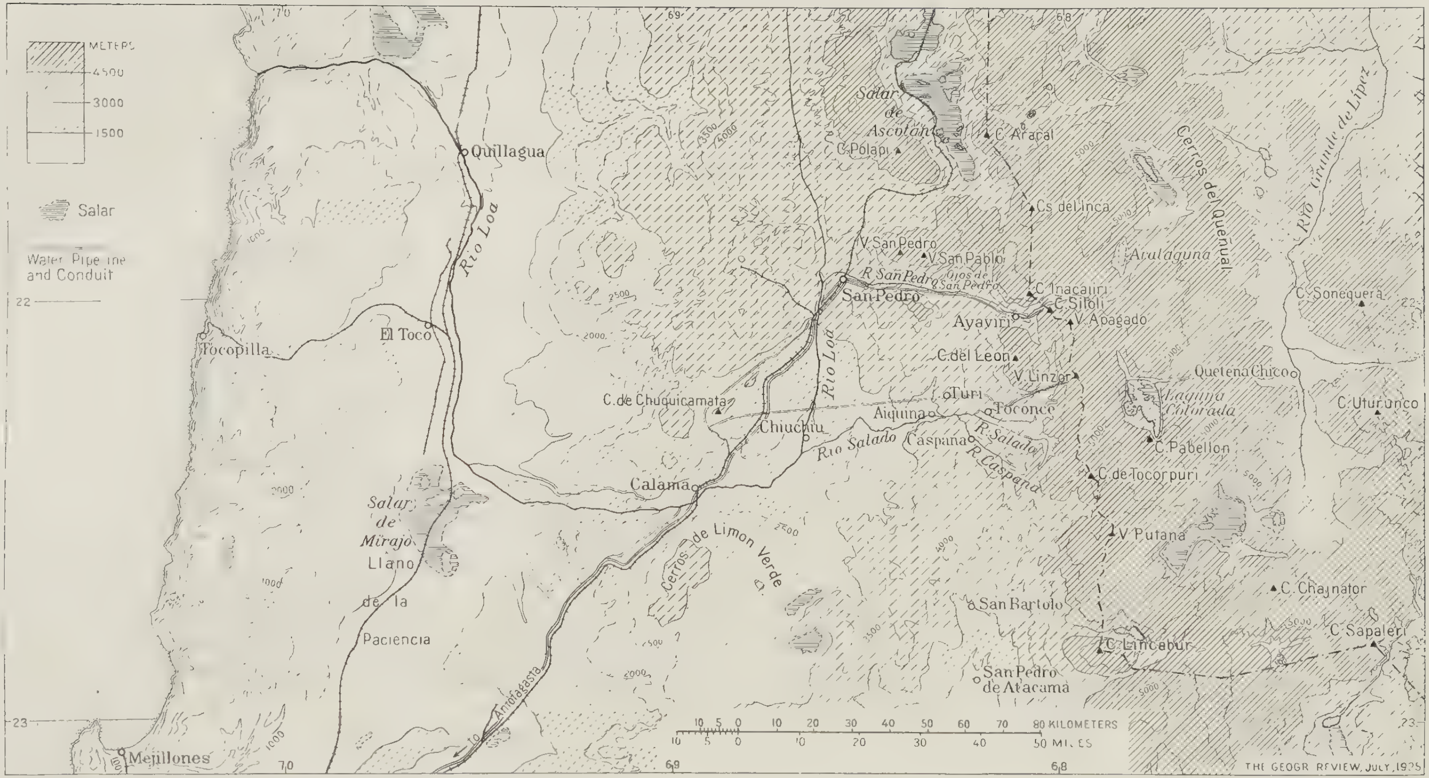

FIG. 2—Map of a portion of the desert of northern Chile and southern Bolivia showing the situation of the Laguna Colorada. Drawn from the American Geographical Society's Millionth Map of Hispanic America, Iquique sheet, S. F.-19. Scale 1: 2,000,000.

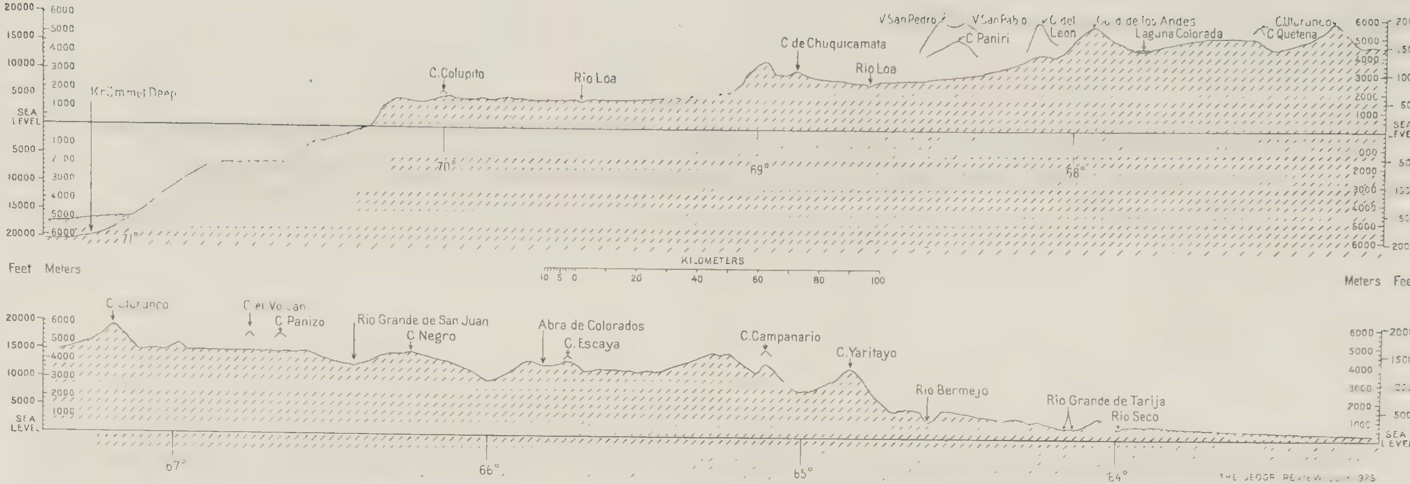

FIG. 3—Topographic section across the Andes along the parallel 22° 17′ S. Drawn from the American Geographical Society's Millionth Map of Hispanic America, Iquique sheet, S. F. 19 (compare Fig. 2 above) and Rio Pilcomayo sheet, S. F. 20. The section illustrates graphically the remoteness of the Laguna Colorada in the south Bolivian desert from the Pacific Coast ports on the one hand and the plains of northern Argentina on the other.

FIG. 4

FIG. 5

FIG. 6

FIGS. 4, 5, 6—The Laguna Colorada.
FIG. 4—The piedmont slope west of the lake.
FIG. 5—Looking south by east from the camp; gypsum deposits fill half the lake.
FIG. 6—Clouding up for the afternoon storm.

Fig. 7

Fig. 8

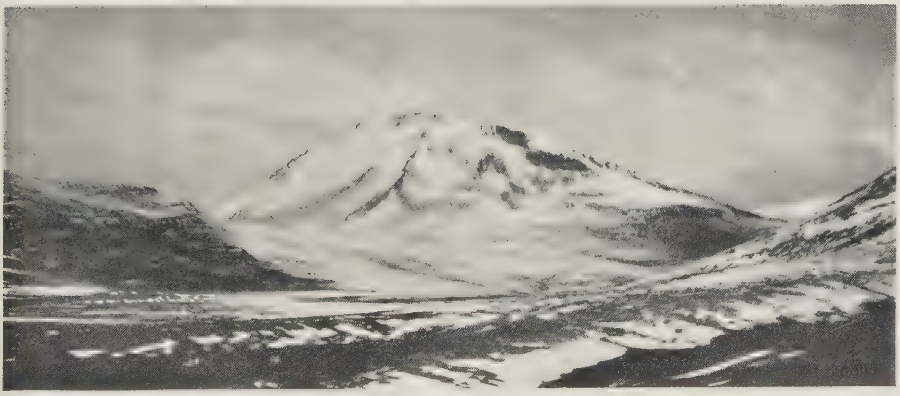

Fig. 9

Fig. 7—Indian rock dwelling on the road into the Laguna Colorada basin. Mt. El Leon in the background.
Fig. 8—On the high pass (17,600 feet) leading out of the basin.
Fig. 9—Mt. Toconce from the pass.

collective name given to the basins, valleys, salt-covered basin floors, mountain knots, chains, and alluvial piedmont deposits that are the chief topographic and drainage features of a belt of exceedingly high and cold country"[3] that forms the southern Central Andes. Everywhere the results of volcanism are dominant. The Colorada basin lies between the Western Cordillera, the summits of which here rise to great altitudes, and the western border of the eastern ranges, here a broad mass of chaotic topography (see section, Fig. 3). West and east the landscape is developed on great masses of greenish-gray andesite which may date back to the early or middle Tertiary. From the base of these more ancient lavas rise young volcanic cones, some of them still active. The floor of the intervening depression, here about 50 miles wide, is mantled with rock waste. From it rise isolated fragments of a central range composed chiefly of a maroon-colored rhyolite much older than the andesitic lavas east and west. The crumbled sand-blasted remnants of the old range assume most grotesque shapes, in some cases resembling human heads and recumbent animals. They give the desert a weird appearance, especially towards evening when the setting sun throws these giant forms into bold relief.

We entered this great basin over the divide at an altitude of 15,000 feet and started down the piedmont slope, a gradual incline of greenish-gray sand and fine gravel from three to five miles wide, towards the lake 25 miles away. Not only is the Puna high and cold, it is extremely arid. We found oases or springs about a day's ride apart, and at each were signs of life but meager so that practically all the fodder for the mules had to be carried; and with all our careful planning they went on starvation rations the last three days. Summer (December to March) is the stormy season, however, as we soon discovered. The pack train had scarcely got under way when a 30-mile wind filled with snow and hail struck us full in the face. In an hour it had blown over and was creeping up the steep sides of El Leon, 19,000 feet, a magnificent sight. But it turned back on us again—a 50-mile wind, with hail, then rain and coarse sand and an accompaniment of thunder and lightning. The thermometer registered 37° F., a drop of 30 odd degrees in less than an hour, and it kept dropping until it reached 28°.

In various phases the storm kept up until nearly dark, but just as we were reaching the *laguna* the clouds broke away to give us a glimpse of the promised water, a shallow lake of brick-red color streaked with bands of white and all over the bright waters myriads of pink flamingos. Snow-capped peaks rose to the east and the west, and fuming volcanoes flanked in black and red. The clouds overhanging the lake reflected the red and pink of water and flamingo. Involuntarily we hissed our mules to stop and sat there aghast, overawed by the unique beauty. Some minutes of silence and Perkins quoted the words of the Lord to Moses upon reaching the Red Sea with the children of Israel. I have seen what they saw, but it is not comparable with this newer "Red Sea" for color or grandeur.

[3] Isaiah Bowman: Desert Trails of Atacama, New York, 1924, p. 257.

Animal Life of the Desert Plateau

We spent three days exploring the Laguna Colorada and studying its animal life. The lake is ten miles long by five wide and 13,760 feet above sea level according to our observation. The red color is due to minute crustaceans on which the flamingos feed, an association observed by Darwin on the Patagonian salt lakes.[4] Its waters are strongly alkaline, but at the northern end where we camped we found several large springs. Bordering the lake and running into and across it and extending from a few inches to seven or eight feet above the surface of the water are long finger-like bars—salt deposits of various composition. They include common salt, borax, gypsum, carbonates of sodium and potassium, and sodium sulphate and iodate, ranging in color from snow-white to gray and chrome yellow. They constitute the chief resource of the region, but the chance of their utilization would seem remote. The borax of Ascotán is fortunately situated with regard to the railway. On the more accessible edges of the Puna there is some trade, chiefly local, in the products of the salars, but for the Puna as a whole transportation is prohibitive.

Fig. 10—Sketch map of the Laguna Colorada.

The animal life of the region is scarce but interesting. The track of an occasional rhea was seen and signs of vicuña. The latter are now so rare that the Bolivian government has made it illegal to kill them at any season of the year. The fact that we saw in one day 21 of these curious-looking animals, deerlike with the long straight neck of the llama, indicates the remoteness and inaccessibility of the lake rather than abundance of vicuña. They are exceedingly shy. The viscacha, which is not unlike our western jack rabbit in size and color, was found in many places at the foot of the rock-covered slopes of the western range; and near the lake were tunnelings of large colonies of chilulu, a rodent related to the chinchilla and about half the size of our domestic rat. The chilulu honeycombs certain selected areas of the desert in an inconceivable way. Whenever our mules reached a chilulu-infested area they became frightened, for they would break through every few steps, sinking through the hard-baked crust of the surface to a depth of 12 to 18 inches. The natives state that the common variety of the

[4] C. R. Darwin: Journal of Researches into the Natural History and Geology of the Countries Visited During the Voyage of the H. M. S. "Beagle" Round the World, London, 1886, pp. 66–67.

chilulu often crosses with the chinchilla whose fur is so much in demand. A small, reddish-gray fox also lives in the Puna, probably on the viscacha and chilulu.

The bird life of the region is confined to a small number of species and very few of each except the flamingo. On the way in from San Pedro station to the central plateau at the infrequent spring holes or small shallow ponds along the western slope we found the gray-colored crested duck (*Anas cristata*), called by the natives *pato juayal*, and the black-winged ground dove (*Metriopelia melanoptera*), "Tortola cordillerana." At the Laguna Colorada were several pairs of black-and-white geese (*Chloëphaga melanoptera*). Several score of fresh-water gulls (*Larus serranus*) were living on the lake, but we found no evidence that they were nesting in that vicinity. The flamingo eggs were probably the attraction. A few pairs of avocets (*Recurvirostra andina*), black and white, closely resembling our own western bird, were seen wading near the shore at the northern end of the lake where fresh-water springs empty, and several pairs of the seed snipe both large (*Attagis gayi*) and small (*Thinocorys orbignianus*) varieties. The seed snipe resemble the ptarmigan of northern Canada more than our snipe. They were usually wading in shallow water and on marshy ground near the fresh-water springs, but their short legs and thickset brown bodies seemed incongruous in that environment. The male of the larger variety has a powerful thrilling call, all the more striking heard in the silence of that desert country. It is the flamingo, however, that is the outstanding feature of the Laguna Colorada.

Flamingos and the Trade in Eggs

By circling most of the lake shore and wading into the center from the north and east we could estimate quite accurately the numbers in the different groups or flocks, and we put the total at approximately 20,000 birds. There were fully 7000 nests near the east center of the lake. The Indians have discovered this colony of flamingos and rob the nests, baking the eggs and packing them down to their villages for food. Riso-Patron reported sale of the eggs in San Pedro de Atacama and Calama at 40 centavos. Perkins had observed the business two years before when he visited the lake, but we had no conception of the extent of this egg traffic until the arrival of a shriveled specimen of humanity with four small burros to gather the last of the season's eggs to pack out to Toconce where he lived.

His name was Escabel. He knew the wading courses to the nests, and his skin was callous to the strong alkaline water of the lake. He approached the nests from the center of the east shore, feeling his way through the opaque red water with a staff. Escabel told us the flamingos began to nest that season about December 12 and stopped about the middle of January. Eight or ten Indians gathered practically every egg laid this year. The flamingo, according to this egg hunter, lays but one egg a season. They

FIG. 11

FIG. 12

FIGS. 11 and 12—Fantastically worn rhyolite rocks on the route from Siloli to the Laguna Colorada.

are shy; and when the nest is robbed of its one egg the bird never returns to lay a second. The hunters start with fresh eggs, and any eggs that cannot be taken ashore the day they are laid are covered with clay so that incubation cannot begin.

Escabel said there were not more than a quarter as many birds in the lake that year as two years before. He insisted that many more birds than we saw were then nesting at Cachi Laguna and Ara Laguna, where there

Fig. 13

Fig. 14

Fig. 13—Approaching the divide from San Pedro. The rounded masses are *llareta*, the woody moss used for fuel.

Fig. 14—Giant cactus at Toconce. Cactus affords the only structural timber of the region.

is not a spear of vegetation or a drop of fresh water. The lakes are reported to be about six hours by mule at a rate of four and a half kilometers an hour (say 18 miles)[5] northeast of our first night's camp, which was 16 miles from San Pedro station. The Indians cannot camp at this lake long enough to gather the eggs, as they cannot afford to transport all the food and water necessary, and so the flamingos may be saved; but the colony we saw is probably doomed.

The eggs are baked in stone ovens, of which we saw several on the shore of the Laguna Colorada. It is useless to attempt to boil eggs at that altitude, about 14,000 feet, for it takes at least 40 minutes, the water boiling at 85° C., or 185° F.

We watched the flamingos feeding and flying for three days, little suspecting at the time that these birds which we saw in thousands were the

[5] Our average rate of traveling time on the Laguna Colorada trip was two and a half miles (4 km.) an hour.

little-known *Phoenicoparrus andinus*, of which there was probably no specimen in the United States. We assumed that they must be the well-known Chilean form (*Phoenicopterus chilensis*), which is seen in small numbers on many of the lakes and marshes from Peru to southern Chile and in the Argentine. The Laguna Colorada bird is slightly larger and of a deeper rose color, with a peculiar lemon-yellow bill, with which it strains the minute crustaceans from the alkaline water of the lake.

Fig. 15

Fig. 16

Figs. 15 and 16—Terrace cultivation in the Toconce quebrada. Wheat and alfalfa are the chief crops.

The flamingos were very shy and difficult to approach, but we managed with the aid of a 12-inch telephoto lens to take several thousand feet of film of them in all stages of domestic life. The riot of color as these long, slender, curious birds flew in regular formation like pink clouds against a background of snow-capped peaks or stood silhouetted against red water and glistening banks of white and yellow salts beggars description.

Return from the Plateau by a High Pass

Our provisions having now been exhausted, we reluctantly took leave of this fascinating desert. Preparatory to our departure the Indians made a brew from an aromatic herb, *chuquicondio*, a small light-green plant found in the *llareta* zone, 13,000 to 16,000 feet. It is reputed to have a slowing down action on the heart: certainly we suffered no serious inconvenience in crossing the divide at an altitude where the air pressure is nearly half that of sea level. I may here testify to the excellent results derived from my training in Chuquicamata undertaken on the advice of Perkins and after a study of the findings of the High Altitude Committee in Peru.[6]

[6] J. Barcroft and Others: Observations upon the Effect of High Altitude on the Physiological Processes of the Human Body, Carried out in the Peruvian Andes, Chiefly at Cerro de Pasco, *Phil. Trans. Royal Soc. of London*, Ser. B, Vol. 211, 1923, pp. 351–480.

See also the paper by A. M. Kellas: A Consideration of the Possibility of Ascending the Loftier Himalaya, *Geogr. Journ.*, Vol. 49, 1917, pp. 26–48.

Our route lay southwestward, the first eight miles up a gradual ascent. Then began the climb to the pass through an old blown-out crater. The afternoon storms at the lake had never failed us, and we anticipated heavy snow on the pass. Our suspicions were confirmed. The V-shaped opening of the pass, 17,600 feet elevation according to our aneroid, was badly choked with snow on a rough surface of boulders and broken lava. The last three miles to it were very steep. At the top we found about four feet of freshly fallen snow in the shallowest place. But it was still worse ahead, three or four miles down an incline and up again, the wind blowing a gale and laden with blinding snow. It looked as though three of our mules would give out altogether, but after three hours' battling we got them all through and, the storm letting up, we could look over the western desert slopes and our homeward route. We worked our way down carefully through canyons and gorges cut in great lava flows of brilliantly colored rock worn into fantastic shapes. Neither mules nor men had food or water until we got down to 12,000 feet and the springs of Toconce which furnish with water the Chile Copper Mining camp of 12,000 people, 75 miles away.

Out-of-the-World Villages

The village of Toconce (10,800 feet), 12 miles farther on, is built in the walls of a box canyon 2000 feet deep. The sun was setting as we arrived at this almost terrifyingly picturesque place. We descended into the quebrada and could not find an empty corral for our mules until we had climbed nearly back to the top again. Here we camped, arousing much curiosity on the part of the villagers in the morning, for they rarely see strangers and scarcely ever a white man. I spent the day in this strange village, going on in the late afternoon to Aiquina (10,250 feet) where I found lodging in a small adobe hut 12 by 15 feet with a walled backyard 12 feet square which served as a kitchen. The rafters for the straw roof are hewn out of the giant cactus, light and porous, but tough and lasting forever in this arid climate. The wood opens up like lacework when cut into one-inch boards, and doors of it afford ventilation to the windowless huts. Built tier upon tier on the sides of the quebrada, Toconce and Aiquina reminded me of the Pueblo villages of New Mexico, a resemblance that has been noted by others.[7] Aiquina occupies a commanding position in the basin of the Salado which stream unites with the Loa at the important oasis of Chiuchiu, 35 kilometers northeast of Calama. It thus has the distinction of standing on the only through-flowing stream in a 600-mile stretch of desert. On the left bank halfway between Toconce and Aiquina the Salado receives the Caspana which supports a village (10,700 feet) of the same name.

The three villages, Toconce, Aiquina, and Caspana, are little known and receive scant mention in the literature of the region. The fullest account

[7] F. J. San Roman: Desierto i cordilleras de Atacama, 2 vols., Santiago de Chile, 1896; reference in Vol. 1, p. 234.

FIG. 17

FIG. 18

FIG. 17—Toconce canyon.
FIG. 18—Aiquina village: houses built on the sides of the quebrada.

is given by Riso-Patron, a member of the Chilean Commission engaged in demarcating the boundary with Bolivia in 1903-1904.[8] Riso-Patron credits Aiquina with a population of 137 (census of 1907), Toconce with 30, Caspana with 132. The villages grow chiefly alfalfa, maize, and wheat. In Toconce five hectares are under cultivation. An aqueduct built across the valley by the natives is a noteworthy feature. In Caspana over ten hectares are cultivated on the slopes of the quebrada: this area is walled off in summer to keep out the cattle but is opened to grazing in May after the harvest has been gathered. Water in the Caspana is sweet but limited in quantity,

FIG. 19—Aiquina village and its ancient church.

and the *turno* for the regulation of water rights has been established. In Aiquina water is entirely derived from springs, the Salado, a highly mineralized stream whose source is in geysers that here occur both east and west of the divide, being unfit for use. The system of irrigation is by *canchones*, series of terraces one or two meters broad on the northern slope of the quebrada.

The villagers are chiefly dependent on their flocks and herds, which graze on the not too abundant upland pastures. Riso-Patron found the meadows of Inacaliri, north of the San Pedro River, eaten bare by the llamas, burros, and sheep of Toconce. The herdsmen of that village had built huts there for usage in the summer. Bertrand, writing in the eighties, described the people of Aiquina as carrying wood to the then flourishing mines of Caracoles south of Calama.[9] Aiquina and Toconce have a single alcalde, elected annually on September 8, a day on which is celebrated the feast of the

[8] La linea de frontera con la República de Bolivia, República de Chile, Oficina de Mensura de Tierras, Santiago de Chile, 1910.

[9] Alejandro Bertrand: Memoria sobre la esploración a las cordilleras del desierto de Atacama, *Anuario Hidrogr. de la Marina de Chile*, Vol. 10, 1885, pp. 3-299; reference on p. 268.

miraculous image of the Virgin of Aiquina. Caspana elects its alcalde on New Year's Day.

The villages have retained their primitive character of pre-Spanish days. Like other settlements in the Puna and Desert of Atacama they show the effect of Inca influence, all this region having been conquered in the first half of the fifteenth century, a hundred years before Almagro made his famous journey into Chile. The inhabitants of Toconce have been pronounced a distinctly "Inca" type: certainly they differ from the general Indian type of the region in physiognomy and complexion. The great Inca

FIG. 20—Aiquina. Looking east into the Salado quebrada. Note the terrace cultivation.

road through the Desert of Atacama passed through Chiuchiu not far away. There are the remains of a *tambo*, or rest station, at Chac-Inga on the road between the *portezuelo*, or pass, of the Inca and Colana in the San Pedro valley to the north.

Although the villages are in territory now Chilean, they conserve souvenirs of the former Bolivian control. The natives, for instance, keep up the erection of the little straw-thatched shelters along the Turi-Caspana road, a former obligation of Bolivian rule. But the hand of government rests lightly on these as on other communities of the desert. Toconce, for instance, is entirely overlooked in the matter of taxation.

The independence and individuality of the three villages furnish a striking example of what is generally characteristic of the Desert and Puna of Atacama. Though particularly isolated and remote, they are but one group in the long line of settlements bordering the Western Cordillera and dependent on its scant streams and belt of upland pasture. San Pedro de Atacama,[10] the most flourishing of the settlements, owes its importance to

[10] Bowman, *op. cit.*, pp. 236–251.

its cross-Puna communications with northwestern Argentina. There is a trail connecting the oases of the Salado and Loa basins with Rinconada on the Argentine side, but as we have indicated it is very difficult. Boman, speaking of this and the alternative route farther south through Sapaleri, says, "the two routes cross deserts without resources, without forage or fuel, and where drinkable water is found only in certain spots far apart. The latter road especially is practicable only for Indians on foot and llamas."[11] Furthermore, the desert between the Western Cordillera and the Pacific is here at its broadest.

An Almost Unknown Region

Bertrand, who through his exploration for the Chilean government knew well the general region, says of the Laguna Colorada: "We do not know it, but by what we have heard it should be included among the most extensive [basins] of the region."[12] Perkins believed himself to be the first white man to have seen the lake. It has, however, been subsequently learned that others have visited the lake, though nothing appears to have been written thereon. The report of the Chilean Boundary Commission of 1904 states that members of the commission crossed the Cordillera at Putana on the 8th of March, arrived at Quetena on the 9th, and returned on the 12th, passing three days of storm with rain and snow and registering minimum temperatures of $-3°$ C. (26.6° F.) at Laguna Colorada and Tocotocare, west of the lake, on March 11 and 12 respectively. Our lowest figure was 26° F. at Laguna Colorada on February 3 at 6 A. M. At noon of this day the temperature was 63°. On February 2 the temperatures at 6 A. M. and noon respectively were 35° and 68°.

Fig. 21—Aiquina women.

A Great Desert

For each one who has seen the great cordilleras that stretch the length of the South American continent, 3500 miles from north to south the term "Andes" holds a different significance according to the particular section

[11] Éric Boman: Antiquités de la Région Andine, de la République Argentine et du Désert d'Atacama, 2 vols., Paris, 1908; reference in Vol. 2, p. 710.

[12] Bertrand, *op. cit.*, p. 207.

or sections studied, so varied are the characteristics—geological composition, physiographic development, faunal and floral life. The section through the Laguna Colorada from west to east (see Fig. 3) is above all distinguished by its desertic character, the paucity of life, and limitation of resources to mineral ores and nitrates or other salts the occurrence of which is in part dependent on this very aridity.

On the desolate, rainless coast swept by the cold Humboldt Current (see Appendix) is a town of over 5000 people, Tocopilla. The reason for its existence is seen in the ships that crowd the harbor for cargoes of the product of barrenness that restores the impoverished soils of the fertile lands. The nitrate oficinas behind the Coast Range bring a crowded life to the pampa, and on the western flanks of the Cordillera is the great mining camp of Chuquicamata, the greatest known copper deposit. All three population groups are absolutely dependent on outside resources for support. In contrast are the ancient oases of the Loa valley, Calama and Chiuchiu, important not only because of their precious water and vegetation but because of their easy relations with the foregoing groups. But a desert oasis not on a highway is a lost world. The tiny villages of the upper Salado basin are in a cul-de-sac. Two hundred miles of desert plateau, averaging over 14,000 feet in elevation, cuts them off from the Jujuy valleys, the first highways to the east. The salts of the Colorada basin remain untouched, its extraordinary scenery unexploited. But herein, of course, lies the principal charm for the traveler.

Fig. 22—Aiquina man: the type is said to be Inca.

APPENDIX

The Recent Occurrence of "El Niño"

In the above text I have referred to the Humboldt Current as an agent in desert making. As is well known there are periodic lapses in the normal regimen of the current especially in its course off the north Peruvian coast. At such times the cold northward-flowing current is replaced by the warm south-flowing *El Niño*. Mr. R. C. Murphy has briefly described the phenomenon in his paper "The Oceanography of the Peruvian Littoral with Reference to the Abundance and Distribution of Marine Life" (*Geogr. Rev.*, Vol. 13, 1923, pp. 64–85). This year (1925) has witnessed a most remarkable occurrence of *El Niño*. I have received an account of personal observations on it during March from Mr. G. S. Dexter, captain of the Grace Line Steamer, *Santa Luisa*, sailing between Balboa and Talcahuano. The

accompanying table (Table I) gives in graphic form water temperature readings taken from the *Santa Luisa* at depths of 24 feet below the surface from Pisco southward to Talcahuano and return north to Talara. The readings were taken every four hours. Readings at the ports of call during a normal season are added by way of comparison. Note should be made not only of the high figures but also of the irregularities, the more remarkable because the depth at which the readings are taken removes accidental fluctuations liable to occur at the surface.

Further data from Mr. Dexter's report follow:

"We had more or less current with us all the way out from Balboa to Chañaral and also a southerly set of the current on the return trip all the way from Valparaiso to Balboa.

"There were far fewer fish visible than formerly and much less plankton. Many dead birds were seen in the water as far south as Tocopilla. In fact, off Tocopilla I saw more dead birds than anywhere else, but the current may have brought these down from farther north. Birds were so weak that in many cases after trying vainly to overtake the ship and cross the bows they fell in the water. Little bird life was visible around the Lobos de Tierra and Lobos de Afuera Islands. I passed very close to the Guañape Islands in broad daylight both in going south and in coming north. Where there were millions of birds when you went with us (1924) there were now but a few feebly flying hundreds. By the aid of powerful glasses we could see that at least 95 per cent of the nests were deserted. I passed close to the little Macavi Islands that lie about forty miles west of Salaverry and was surprised to find more birds there than ever before. In fact, there appeared to be not one inch of standing room on these islands.

"Northwest winds with the force of half a gale blew for some time around Talara and Paita, wrecking most of the lighters at Paita. This is usually a very fine weather harbor, being sheltered from the prevailing southwest winds and seas.

"Talara and Salaverry experienced very heavy rains, and much rain has fallen everywhere in the interior, melting the mud roofs and in some cases the walls of houses all over Peru. Thunder and lightning, practically unknown on and off this coast, were frequently reported; and a great deal of static was reported by the radio operators. Water pipe lines were washed out at Arequipa and many towns. Lima and Callao were in darkness and short of drinking water. It will take eight months to rebuild the railroad to Cerro de Pasco. An epidemic of disease is expected. Mosquitoes and flies, previously unknown, are already a pest. Everywhere the barren coast is becoming green. A river with 17 feet of water in it cut through at Talara. Two others cut through a short distance north of Talara. Abundance of driftwood was visible at sea. And last but not least the ship bottom has collected more marine growth in the past four months than it would under ordinary conditions in eighteen months. A thick, short coating like a carpet of green moss formed all over her sides, while more than the usual amount of shell growth collected on the flat part of her bottom."

The above report is supplemented by data in a letter received by the American Geographical Society from Mr. Otto Holstein of Trujillo. Mr. Holstein writes under date of April 5.

"I believe I am safe in saying that a table tumbler would hold all the rain that has fallen the three years I have been in Trujillo previous to March just past, the only evidence of rain we ever have being a few scattering drops once or twice a year. On March 4 the rains came down with sufficient force to wash out a section of the road that connects Trujillo with Samne, where are the mill and hydro-electric installations of the Northern Peru Mining & Smelting Co. at a place called Poroto, some 30 odd miles from Trujillo. On the evening of March 7 at about 7.30 o'clock a cloud-burst occurred in Trujillo (about four miles in a direct line from the sea), and it was followed by a light but steady rain which lasted, intermittently, for some

Table I—Water Temperatures off the West Coast of South America Taken at an Average Depth of 24 Feet Below the Surface

Southward Bound, March 6–15, 1925						Port of Call	Northward Bound, March 15–27, 1925						Feb., 1921*
4 A. M.	8 A. M.	Noon	4 P. M.	8 P. M.	Midnight		Midnight	8 P. M.	4 P. M.	Noon	8 A. M.	4 A. M.	
				(78)	(79)	Balboa							
(78)	(78)		(78)	(78)	(77)	Talara, 5° 45′	80	80	**80**	80	78	78	**68°**
(79)	(79)		(79)	(79)	(79)	Salaverry, 8° 15′	83	84	85	**80**	76	76	**64°**
(78)	(77)			(76)	(76)	Callao, 12° 05′	78	78				**78**	**64°**
(67)		60	60	62	68	Pisco, 13° 42′	78	70	81	70	65	65	
65	64	68		68	**68**	Mollendo, 17°	79	76	79				**64°**
69			**69**			Arica, 18° 28′							
					63	Iquique, 20° 13′			67	63	68	**65**	**60°**
68				**68**	68	Tocopilla, 22° 05′		**75**	75				
					70	Antofagasta, 23° 39′		75	75	63	68		**58°**
										67	67	65	
70	70			**68**	69	Chañaral, 26° 20′	65	67	67	67	64	65	
68	68	64	64	64	63								
63						Valparaiso, 33° 1′	65	67	67	**70**	65	65	**56°**
62		64	65	65	65								
65	65	**64**				Talcahuano, 36° 42′	65	65					

Bold-face figures are temperature readings taken at or near the port of call.
Figures in parenthesis represent surface-water readings from Balboa (March 1) to Pisco.
*Noon readings taken at a depth of 20 feet below the surface.

four days and nights. The houses here are not built to resist any rain at all, and it wasn't long before roofs were leaking like screens and water commenced pouring down the walls. To make matters worse, the roofs are made of mud mixed with manure, and the water that filtered through was polluted and foul smelling. These rains continued, with breaks of three or four clear days between, and in varying intensity, during the entire month of March and caused considerable damage to Trujillo by caving-in of roofs, falling of walls, and the like. On April 3 about 9

A. M., we had a slight earthquake, which was of short duration and not very severe but did some damage by causing weak roofs and walls to fall.

"During March the temperature was decidedly tropical, and the sun—when it made its appearance—was more as it is in Guayaquil and other places in the true tropics. This condition of affairs extended from Talara, north of Paita, as far as Lima; but farther south it did not rain to any appreciable extent on the immediate coast, although the rains in the Sierra were more torrential than have ever been known. The Peruvian Corporations railway lines have suffered greatly; the Southern railway was badly damaged by washouts some months ago, and the Central railway of Peru from Callao to Oroya and Huancayo is badly crippled. The Chimbote line suffered, and the Trujillo railway was cut between Trujillo and the port (Salaverry), between the valley (of the Chicama) and Trujillo, and between Trujillo and Menocucho. In fact, there are only two trains operating on the whole line, one between Salaverry and the Moche River bridge and one between the bridge and Trujillo, passengers, baggage, and the mail being transferred by an improvised aerial tram across the river. The Pacasmayo railway suffered greatly, as did the Paita-Piura line.

"There are hundreds of homeless families here in Trujillo and in the vicinity, and it is difficult to estimate the monetary loss suffered as a result of the storms.

"Since yesterday there has been a decided change in the climate. I am informed that the sea water at Salaverry and elsewhere along the coast is of more or less normal temperature, and there is also a decided freshness to the air. However, there is still the danger of walls falling as they dry, and a little stronger shake than the one we had the other day would bring serious consequences."

THE SIBERIAN SEA ROAD

THE WORK OF THE RUSSIAN HYDROGRAPHICAL EXPEDITION TO THE ARCTIC 1910-1915

By N. A. Transehe
Late Commander, Russian Navy

[With separate map, Pl. III, facing p. 398]

The Great Northern, or Siberian, Sea Road, or, as it is commonly called, the Northeast Passage, has attracted more or less attention since the sixteenth century, when various nations of western Europe tried to find thereby a more advantageous route to Cathay. As is well known, the passage has been accomplished only within the last fifty years, having been made for the first time by the distinguished Swedish explorer A. E. Nordenskiöld on the *Vega*, sailing from west to east in 1878–1879. It is not so generally known that the passage was made in the opposite direction, from east to west, in 1914–1915 by the Russian Hydrographical Expedition to the Arctic. The route of the expedition, the extent of newly surveyed coast including Nicholas II Land, and other results are shown on the map (Pl. III, facing p. 398).

The Earlier Explorations

Even up to the eighteenth century the possibility of such a route remained unknown or doubtful. The relation between Asia and America was only definitely determined by the Great Northern Expedition, planned by Peter the Great and put into execution by his successors. It is to Bering's voyages and the subsidiary expeditions that we owe the first authentic maps of the northeastern coasts of the continent. The work of the Great Northern Expedition has scarcely had the recognition it deserves.[1]

Exploration of the northern territories was continued by various Russian expeditions without startling event, until Nordenskiöld's exploit proved the passage to be feasible. A little later under the auspices of the Russian Navy there developed great activity in the exploration of the Kara Sea route to the Yenisei River. A commercial waterway from Europe to the heart of Siberia was being sought in connection with the Siberian Railroad then in the process of construction. Before that Nansen on the *Fram* had gone by the Kara Sea (1893) eastward to the New Siberian Islands, from which point he began his famous drift.

In 1900 the expedition of the *Zarya*, under the command of Baron Toll, reached the Nordenskiöld Archipelago by way of the Kara Sea. The expedition wintered there in 1900–1901 and at the New Siberian Islands

[1] F. A. Golder: Bering's Voyages, Vol. 1, *Amer. Geogr. Soc. Research Series No. 1*, 1922.

Fig. 1

Fig. 2

Fig. 1—Petropavlovsk, capital of Kamchatka, was a port of call for the expedition between the base in Vladivostok and the Arctic Ocean. In the background is the snow-capped volcano Avacha.

Fig. 2—Novo Mariinsk at the mouth of Anadir Bay, one of the last ports of call for the expedition before entering the Arctic Ocean.

Fig. 3

Fig. 4

Fig. 3—Cape Dejnev, named for the Cossack hunter to whom has been attributed the prior discovery of Bering Strait in 1648. Chukchi settlement at the right (see Fig. 4).
Fig. 4—Chukchi settlement at Cape Dejnev (see Fig. 3).

the next year, after which Tiksi Bay, in the mouth of the Lena River, was reached, where the vessel was abandoned on account of lack of coal.

It is not generally known that a participator in this expedition was the late Admiral (then Lieutenant) Kolchak. He made a notable journey by whaleboat from the mouth of the Lena River to Bennett Island in search of Baron Toll. While he did not succeed in tracing the lost members of the expedition, he found their camp and returned to the mouth of the Lena by the same way, bringing with him Toll's diary and part of his collections. Kolchak's work "The Ice of the Kara and Siberian Seas," presenting his systematic observations of sea water and ice cover for two years of navigation on the *Zarya*, was published by the Academy of Sciences.

The *Zarya* was the last scientific expedition engaged in exploration of the waters that wash the shores of northern Russia up to the mouth of the Lena River. For the part of the Arctic Ocean from the Lena to the Kolima River and beyond to Bering Strait the situation was still worse, as since the Great Northern Expedition the explorations undertaken in this region had been more limited in scope. These included the Russian expeditions of Lieutenants Anjou, Wrangel, and others; that of the *Vega;* the unfortunate American expedition of Lieutenant De Long on the *Jeannette;* and a number of Russian coast expeditions and isolated whaling ventures which had penetrated into the waters of the Arctic Ocean along the coasts of Siberia, a distance of a few score miles or so, seldom of 100 miles, from Bering Strait.

The data gathered by these voyages and explorations were insufficient to determine the possibilities for the establishment of regular navigation —which time and circumstance now brought to the fore as a desideratum.

During the Russo-Japanese War Russia had been compelled to transfer its Baltic fleet to the Far East through three oceans, from the Atlantic to the Pacific. After the war interest was directed to the hope, a slight one it is true, of utilizing the Northeast Passage in similar cases in the future. The Navy, which had indeed been interested in the exploration of the northern waters since the time of the Great Northern Expedition, was desirous of putting it to the test. From Archangel to Vladivostok via Bering Strait is a distance of about 6000 miles, about half that of the route from the Baltic through the Indian Ocean.

Still more important than the strategic were the economic considerations, viz. the provisioning of northeastern Siberia by a cheaper way—from Vladivostok by sea through the Arctic Ocean into the Kolima River, instead of the way, as practiced at the time, of transporting supplies down the Lena River, then by dogs or deer to the Kolima River and the Government warehouses. Some attempt at commercial communication by sea from Vladivostok to the Kolima was indeed already in progress. The result of these eminently practical considerations was the creation of the Russian Hydrographical Expedition to the Arctic Ocean.

The Russian Hydrographical Expedition Created

In Petrograd two vessels, the *Taimir* and the *Vaigach*, were constructed. These vessels were sister ships of ice-cutting type, i. e. made of iron and built on the lines of the *Fram*. Each vessel was of 1500 tons displacement and carried 500 tons of coal, sufficient for a speed of eight knots during 60 days of navigation, or for 12,000 miles. Each ship was equipped with wireless with a transmission capacity of 100–120 miles. The personnel of each vessel was five officers, one mechanical engineer, one doctor, and a crew of 40. Food supply (mostly canned) was carried for 16 months and customary Arctic outfit except that there were no dogs, owing to the lack of space for them and their food. There was complete equipment for work in cartography, meteorology, oceanography—including biology of the ocean—and in other branches of natural sciences.

In the spring of 1909 the vessels were launched from the dockyards, and in autumn of the same year they sailed from Petrograd to Vladivostok through the Indian Ocean, there to establish the expedition's base. Kolchak, who was the organizer and leading spirit of the expedition, was first in command and sailed on the *Vaigach*—Mattisen, who also had been a member of the *Zarya* expedition, being in command of the *Taimir*.

The main reason for the transfer of the base of the expedition was that the eastern portion of the route remained almost unexplored, whereas hydrographical knowledge of the Kara Sea was steadily advancing, more or less regular navigation to the mouths of the Ob and Yenisei Rivers having been in progress since 1867. The expedition also would have the opportunity of doing hydrographical work on its voyages from Vladivostok to the Arctic Ocean, a distance of 3000 miles. Furthermore, it was planned to attempt the Northeast Passage as a culmination to the systematic work, and an approach from the east offered a slight advantage (10–12 days), precious when navigation time is so short, two months at the maximum. Besides these considerations it was thought expedient to put the newly built vessels to a test by the long journey to Vladivostok, a wise foresight as it proved.

Work of 1910 and 1911

Because of the delay entailed by boiler repairs the expedition during 1910 made only a brief reconnaissance trip into the Arctic Ocean as far as Cape Intsov and back to Vladivostok, carrying out some hydrographical research work in the Bering Sea.

The following year the expedition was deprived of its director and commander, Kolchak, having previously lost Mattisen, both men of experience in polar navigation.

The instructions for the year's work are typical. They were:

1. To make a survey of the coasts and adjoining islands from Cape Dejnev westward. The basis for the survey was to be astronomical sta-

FIG. 5

FIG. 6

FIG. 7

FIG. 5—Drift ice aground on the coast of Jokhov Island.
FIG. 6—Tundra in Kolyuchin Bay: grave of the sailor Byeliak.
FIG. 7—Sledge party in search of Baron Toll's collection on Bennett Island.

FIG. 8

FIG. 9

FIG. 10

FIG. 8—Ice pushed up on shore at Cape Chelyuskin.

FIG. 9—The western coast of Taimir Peninsula: astronomical beacon and graves of Lieutenant Jokhov and the sailor Ladonichev.

FIG. 10—Crossing a river in the tundra.

tions on the coast at distances of 50–60 miles from each other, if possible. Soundings were to be made along the entire route.

2. To make a survey of bays, mouths of rivers, anchorages in general, and especially anchorages of rivers, which would serve as places of shelter from ice. The survey of the safest anchorages was to be made by plane-table and soundings from the ships' boats.

3. To establish signals for the needs of navigation, also in anchorages which would serve as refuge places from ice.

4. To perform hydrological, magnetic, meteorological, and biological research.

5. To make surveys of currents and movements of ice.

6. To take soundings on lines normal to the coast, in order to determine the general character of the relief of the bottom.

In addition the program was always to include the following:

1. Hydrographical work on the way from Vladivostok to the Arctic Ocean, primarily along the coasts of Kamchatka and Bering Sea.

2. Notes on sailing direction in the Arctic Ocean and of the route from Vladivostok to Cape Dejnev.

Upon completion of the systematic work to the mouth of the Lena River the expedition was instructed, if the conditions of the ice permitted, to proceed with the survey farther to the west, to the north of Cape Chelyuskin along the western coasts of the Taimir Peninsula.

Following the above-named instructions and having, for 1911, a limited area of exploration in the Arctic, i. e. to the mouth of the Indigirka River, the expedition under its new command started out from Vladivostok, completed the prescribed work to Cape Dejnev and from there, entering the Arctic Ocean, proceeded to fulfill its chief task—the coastal survey.

Encountering on the way varying conditions of ice and from time to time being held up by it, the expedition reached as far as the mouth of the Kolima River. On the way back a tack was made to Wrangel Island. On the southwestern extremity an astronomical station was established from the *Vaigach*, and the west coast of the island was surveyed: the northern shore could not be approached near enough for surveying. As a result of the season's work the Hydrographic Office the following year published a map of the Arctic Ocean from Dejnev to Kolima, with the addition of Wrangel Island, according to the new data.

During 1911, for the first time, the steamer *Kolima* of the Volunteer Fleet made a successful commercial voyage from Vladivostok to the Kolima River and back, inaugurating a regular steamship service along this route.

Work of 1912

During this year the expedition started out from Vladivostok with the intention of spending a month and a half in hydrographical work

FIG. 11

FIG. 12

FIG. 11—Driftwood at Cape Titka, Blijni Island of the New Siberian group. The wood is probably carried thither from the mouth of the Lena River.

FIG. 12—Driftwood at the mouth of the Kolima River.

along the coasts of Kamchatka and Bering Sea. The Arctic Ocean was entered on July 22,[2] up to which time ice was encountered only in Anadir Bay. With minor delays on account of ice conditions, primarily on the line from North (Syeverni) Cape to Wrangel Island, the expedition reached the mouth of the Kolima River on July 29 and, directing its course toward the Bear Islands, made a survey of them, establishing astronomical stations thereon. From the Bear Islands to the meridian of the Indigirka River and beyond to Laptev Strait it was impossible to approach within 20 miles of the coast because of the shallowness of the water (depth 20 feet).

The New Siberian Islands were reached on August 9. After the position of Cape Titka on Blijni Island had been established a survey of the southern coasts of the entire group of the islands was made. The expedition then crossed Laptev Strait and defined Cape Svyatoi Nos, while the astronomical station established during one of the previous coast expeditions was connected by triangulation with the one established during this expedition, a fact of great value for the correction of all coördinates of observations of the coast expeditions.[3] On the way from Cape Svyatoi Nos to the mouth of the Lena River, a partial survey of the coast was made, and on August 22 the expedition arrived in Tiksi Bay to the south of the delta of the Lena, where was seen Baron Toll's yacht *Zarya*, abandoned for lack of coal in 1902. Tiksi Bay may sometime serve as an outport for the Lena River.

In this neighborhood a souvenir of the tragic expedition of Lieutenant De Long was encountered. A Tungus, Afanasi Bobrovski, visited the vessel; before entering into conversation he solemnly took out from a box two medals and hung them on his breast. One, gold, had been given to him by the President of the United States for "Courage and Humaneness;" the other, silver, was from the Russian Government for "saving the perishing." Bobrovski related that he received these medals for services rendered to Melville of De Long's expedition.

On August 28 the expedition set forth again, doubling the delta of the Lena River and shaping its course toward Cape Chelyuskin. Impassable ice, however, soon compelled it to turn to the south near the mouth of the Anabara River. Here precious time was wasted in irresolute action, the expedition moving along the coast back and forth until September 5, when it was announced that it would return to Vladivostok. Without accomplishing further work, except some soundings and meteorological observations, the expedition proceeded to Cape Dejnev, anchoring there on the 22nd. On the way to the cape walrus hunting was engaged in, which supplied the Zoölogical Museum of Petrograd with excellent specimens.

[2] The new calendar is used in all instances.

[3] The principal astronomical positions found by the expedition were made on land. Latitude, local time, and azimuth were determined in most cases with great precision by observations on stars with a large Hildebrand micrometer theodolite. Differences of longitude were determined by the transportation of twelve chronometers, each of which was checked for rate before and after the expedition.

FIG. 13

FIG. 14

FIGS. 13 and 14—The northern (Fig. 13) and southern (Fig. 14) shores of Bennett Island. Snow fields occur on the northern shores, but glaciers do not descend to the sea as they do on the southern side of the island.

The preparing of the walrus was done by Chukchi, from a settlement near the Cape. Their zeal in taking off the hides was explained by their hunger as, owing to bad weather and absence of sea beasts, the population was suffering from lack of food.

The cartographic work of the seasons 1911 and 1912 may be summarized thus:

FIG. 15—A cliff of ground ice on Vasilievski Island, one of the New Siberian group, where the phenomenon attains a remarkable development. Compare with the illustrations from Baron Toll reproduced by Leffingwell in "The Canning River Region, Northern Alaska," *U. S. Geol. Survey Professional Paper 109*, 1919 (Pls. 33 and 34), and see also Leffingwell's discussion of the ground-ice problem.

1. On the Arctic coasts 17 astronomical stations were established, and 5 on the coast of Kamchatka.
2. A survey of the coast from Cape Dejnev to the Kolima River was made.
3. A survey of part of Wrangel Island was made.
4. A survey of parts of the Bear and New Siberian Islands was made.
5. A survey of parts of the coasts of Laptev Strait and of the Anabara River was made.
6. Errors as to the longitude of the eastern Taimir Peninsula were determined.
7. On the entire route soundings were carried out, in some places with the construction of hydrologic sections showing the currents at various depths.

The work done permitted material correction of existing maps of the Arctic Ocean and the preparation of sailing directions for the Arctic as far as the Lena River.

The Work of 1913

In contrast with the preceding work directed primarily to an immediate commercial objective, the navigation of 1913 was one of wide exploration which resulted in important geographical discoveries. On August 5 the expedition, after battling with the ice in Anadir Bay, entered the Arctic Ocean. The *Vaigach* proceeded to Wrangel Island but was unable to approach its shores because of ice. A survey of the Bear Islands was made, and thence the vessel sailed along the coast via Laptev Strait towards the Taimir Peninsula. Shallow waters prevented the survey of the mouth of the Olenek River, but some important work was done in Nordvik Bay. The supposed peninsula at the southeastern side of the bay was found to be an island. Its southern shores were surveyed. Hydrological sections were made in the bay, the depth of which ranged from 11 to less than 4 fathoms. While in the shallows a six-foot ebb left the *Vaigach* stranded, but she was refloated by the returning high tide. She grounded again later in latitude 75° 30′ N. while surveying Pronchishcheva Gulf. The *Taimir* proceeded along the coast, completing the soundings in Chaun Bay and thence turning northward to the New Siberian Islands. On August 20 the *Taimir* discovered a small island, one and a half miles in diameter and with an elevation of 50 feet, subsequently named General Vilkitski. On August 23 the *Taimir* met the *Vaigach* at the rendezvous agreed on, Preobrajenie Island.

FIG. 16—Tundra in the neighborhood of Tiksi Bay. The cone-shaped hills represent the dissection of the ground ice (see Fig. 15). The hills are of earth covered with a layer of sward several inches in thickness; between is seen ground ice. The hills are separated from the sea by a strip of river sand. Compare the description by Colonel Neyelov: *Report of the Russian Hydrographic Office*, Vol. 38, 1914, pp. 68–113; reference on pp. 79–82.

On August 28 the vessels proceeded northward to survey the coast of the peninsula and of the numerous groups of fringing islands. On September 1 the vessels were stopped by ice from three to five feet thick near Cape Chelyuskin. From the meridian of the Bear Islands or even a little farther east no ice obstruction had been encountered up to this point—an exceptionally favorable condition.

Discovery of Nicholas II Land

In search of open waters to the west the vessels went north. On September 2 a low island was discovered, later named Tsarevich Alexis, 30 nautical miles northeast of Cape Chelyuskin. A survey was made along its southern and eastern coasts. Doubling the island from the east, the expedition went to the northwest, passing several icebergs on the way.

On September 3 the expedition made its major discovery—Nicholas II Land. The significance of this discovery has already been briefly noted in the *Bulletin of the American Geographical Society*.[4] It showed the existence of Chelyuskin Strait and of land stretching far towards the Pole. The existence of such land helps to explain many of the hydrographical peculiarities of the Kara Sea: it also has a meteorological interest. The expedition approached the southeastern extremity of the new land (55 miles from Chelyuskin) but, finding no open water to the west, started a survey along the eastern coast which, in the form of flat-topped mountains, attains a height of 1500 feet. A southwest wind drove away the masses of ice from the coast, forming a wide channel for the passage of the ship. On September 4 astronomical observations gave a position of latitude 80° 4′ N. and longitude 97° 12′ E. Thence compact ice was encountered, which barred the way northward at a latitude of 81°. How much farther north the new land extends remains to be determined. Its maximum dimensions, however, are approximately known from the findings of the *Fram* and the *St. Anna*, the tragic expedition of Lieutenant Brusilov.

Turning back to Cape Chelyuskin still no outlet to the west could be found. For a week the expedition waited, hoping for favorable winds in vain; further attempt was abandoned and the return journey begun. Ice, unfavorable winds, and the growing darkness of the nights added to the difficulties. Petropavlovsk was reached on October 29, where a stay for repairs was made. The expedition finally arrived at its base on November 25 after completing 13,000 miles of navigation.

Work of 1914–1915

The prime object of the 1914–1915 expedition was to complete the Northeast Passage and to continue the exploration of the newly discovered Nicholas II Land.[5]

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[4] See the note "Nicholas II Land," *Bull. Amer. Geogr. Soc.*, Vol. 46, 1914, pp. 117–120.

[5] Cf. also the account "Vilkitski's North-East Passage, 1914–1915," *Geogr. Journ.*, Vol. 54, 1919, pp. 367–375.

On July 7 the expedition started out from Vladivostok *en route* to the Arctic. On the way news of the commencement of the World War was received from America through the radio station in Alaska. In order to get information thereon, the *Taimir* directed her course to Nome. Later through the radio station in the village of Novo Mariinsk on the Anadir River the *Taimir* got in communication with Petrograd and received instructions to proceed with the work in the Arctic Ocean and to try to reach Archangel. The *Vaigach* busied herself in the meantime with hydrological and hydrographical observations in the Bay of St. Lawrence

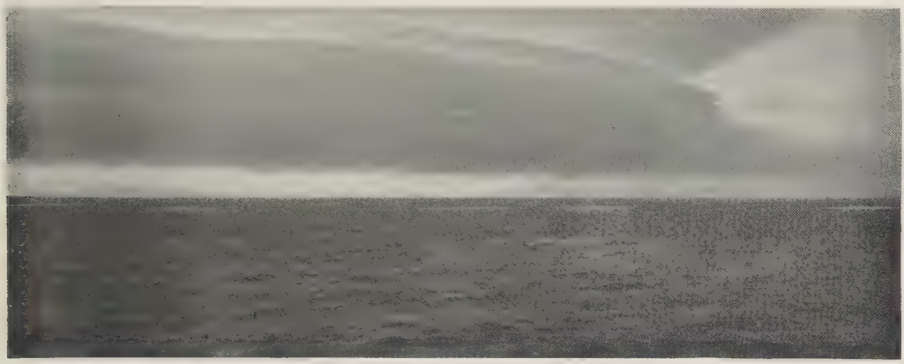

FIG. 17—The first sight of the new land—Nicholas II Land seen September 3, 1913.

and around the Diomede Islands in Bering Strait. Whilst they were thus engaged there came a request from the Canadian Government to render assistance to those members of Stefansson's expedition who, after the wreck of the *Karluk*, had been wintering under unfavorable conditions on Wrangel Island. The *Vaigach* proceeded thither. No efforts were spared to approach the island, which it was known would be accessible not longer than three weeks at most. The first attempts proving unsuccessful, the *Vaigach* tried the approach via Herald Island and the northeast but here met the same insurmountable obstacle—thick, piled-up ice. A slight wind from the north starting up, the vessel then tried to reach the southeast coast of the island but was pressed back. A mass of ice caught in the propeller. The *Taimir*, being informed by radio of the plight of the *Vaigach*, came up but on account of the ice could not approach nearer than ten miles. Eventually the *Vaigach* was freed, but the expedition had to give up the idea of trying to reach Wrangel Island, the work of rescue, it is subsequently learned, being accomplished by the American trading schooner *King and Winge* commanded by her owner Captain Olaf Swenson. At Kolyuchin Bay, on August 19, the vessels took on the last supply of coal from the *Tobol* which had been delegated to provision the ships, and on August 21 the vessels proceeded westward.

Beyond the meridian of Cape Billings an attempt was again made to reach Wrangel Island but without success. Near Cape Yakan, while

[illegible]

Fig. 19

Fig. 18—An old ice field in summer, the surface covered with dirt and fresh-water pools.
Fig. 19—Detail of the ice field seen above.

FIG. 20

FIG. 21

FIG. 20—The *Vaigach* blocked by the ice on attempting to approach Wrangel Island for the rescue of members of Stefansson's expedition from the wrecked *Karluk*.
FIG. 21—Walruses near the shore of General Vilkitski Island.

FIG. 22—Icebergs grounded off the southwest coast of Nicholas II Land, preventing the westward advance of the expedition in 1914.

moving among broken pieces of ice, the expedition noticed a fire on a large ice floe; around the fire were grouped about twenty Chukchis who had been hunting walrus. They asked to be taken to the coast, but as we could not afford to lose any time their request was declined.

After passing the meridian of Chaun Bay the vessels separated, the *Vaigach* going along the coast to the Bear Islands and New Siberian Islands, the *Taimir* going as far north as the ice permitted. Insurmountable ice near the New Siberian Islands compelled the *Vaigach* to change its direction to the north, the intention being to reach the De Long-Jeannette groups and, if possible, also Henrietta Island. Heavy ice again barred the way, and the *Vaigach* made for General Vilkitski Island.

During this journey the *Vaigach* discovered and surveyed an island named Novopashenni, subsequently renamed Jokhov, the coördinates of which were determined as latitude 76° 10′ N. and longitude 153° E. Here she was joined by the *Taimir*.

The vessels separated again, the *Vaigach* proceeding to the north of the New Siberian Islands, with the intention of completing the survey; the *Taimir* to Bennett Island and from there westward as far north as possible to ascertain the boundaries of the ice. Cape Chelyuskin was chosen as the rendezvous.

Shallow depths prevented the *Vaigach* from reaching the New Siberian Islands, and only four days later, on August 31, she approached the coast of the Taimir Peninsula without encountering ice on the way until between the Island of St. Samuel and the mainland.

The *Taimir* encountered bad conditions for navigation and was damaged on the way to the cape in collision with floating ice. Arrived at Chelyuskin on September 2 the expedition encountered large ice fields, which although broken offered little prospect of open water to the west. The vessels anchored near the cape, and a party from the *Taimir* was sent ashore. The ice fields now began to move in the direction of the place of anchorage. The *Vaigach* got under way and succeeded in passing the southeastern extremity of Nicholas II Land and, through a channel of open water in a southwesterly direction along its southern coast, reached a point in latitude 77° 51′ N. and longitude 99° W. Here encountering

FIG. 23—Iceberg aground in 20 fathoms of water off the south coast of Nicholas II Land.

grounded icebergs the *Vaigach* turned back towards Tsarevich Alexis Island and made a survey of its southern coast and of some small islands adjacent.

The *Taimir*, delayed by awaiting the return of the shore party, was caught by the ice and drifted some fifteen miles east of the cape before she succeeded in freeing herself. She met the *Vaigach* on the southern coast of Nicholas II Land.

The vessels started out again to the west but, meeting the same obstacles, turned back and a few hours later anchored on ice under the low southern coast of the new land. While they were waiting there the approach of winter began to make itself felt: the temperature dropped, the tundra began to freeze, the pools were covered with new ice, snowstorms were frequent. During the following days up to September 9, the vessels maneuvered about in a general northwest-southeast direction, between the continent and Nicholas II Land, in search of an outlet to the west. They also anchored at the islands Axel Heiberg and Fernley, hoping that these islands, natural ice cutters when the drift is strong, would be of help. But the results were futile. The islands in the middle of the 30-mile strait stop the movement of the ice fields when weak winds are blowing. There were no fresh winds, and the summer temperature was low this year, an average of $-2°$ C. for the season in the Arctic.

No considerable space of water was free from ice, and the lanes among the fields were unsafe. On September 9 the *Taimir*, upon entering such a lane, was pressed between ice fields; and, because of the hole sustained in collision with the ice, the vessel tilted on one side and could not take the ice properly. The pressure fortunately lasted not more than two to three minutes, but as it was, 70 ribs were broken and 9 water-tight bulkheads were stove in. Two or three days later the *Vaigach* entered open waters and moved along the western coast of the Taimir Peninsula to King Oscar Peninsula near the Taimir River, where she encountered heavy ice and in turn severe ice pressure. The *Taimir* found herself surrounded by ice fields, and preparations were made for walking to the coast in case repeated pressure destroyed the vessel. The necessary three weeks' supply of food and equipment was put on the upper deck.

During the night of the same day, i. e. September 9, the *Taimir*, while communicating by wireless with the *Vaigach*, intercepted fragments of a communication in Russian which proved to be from the *Eclipse*. This vessel under the command of Captain Otto Sverdrup had been sent out by the Russian Government in search of Lieutenant Brusilov and the geologist Russanov, who had set out in 1912 on an eastward voyage to Bering Strait and about whom nothing was known. Sverdrup informed us that he also was in a difficult situation because of ice. He was at that time near Cape Tillo, some 200 miles from us. Being informed of the

Fig. 24—The east coast of Nicholas II Land.

situation of the *Taimir* and the *Vaigach* he promised help with sledge parties: for he had 30 dogs. He gave information about the war, as he had recently received news by wireless from Yugor Strait, a connection now lost on account of the long distance. From that time on the expedition was in daily communication with Sverdrup up to October, after which, in order to save fuel, communications were limited to one a week.

Wintering off the Taimir Peninsula

The situation continued precarious and it became increasingly apparent that the expedition would have to winter on the spot. Eventually the *Taimir* was anchored (September 26) as near shore as possible—at a distance of two and a half miles. The *Vaigach* anchored a mile and a half from the coast of King Oscar Peninsula.

The *Eclipse* reached Cape Vilda, latitude 75° 40′ N. and longitude 91° 25′ E. The vessels started preparations for the winter. Two sheds for the airplane and about one ton of provisions were transferred from the *Taimir* to the coast. This was done in anticipation of a wreck of the vessel during the ice-breaking period of the following year.

On October 19 a storm carried away ice from the shore to the north. The ice field and the *Taimir* with it were halted seven miles from the coast in latitude 76° 41′ N. and longitude 100° 50′ E. The *Vaigach* was situated

in latitude 76° 54′ N. and longitude 100° 13′ E. The distance between the two vessels was 17 miles.

The air-line distance between the vessels and the *Eclipse* was about 100 miles, and from the *Eclipse* to the radio stations in Yugor Strait, which were in touch with Petrograd through the radio stations in Archangel, 800 miles. This distance at first proved too great even for the *Eclipse*. The author of this article, a specialist in radiotelegraphy, succeeded, however, in making computations which, transmitted to the *Eclipse*, enabled her to get in touch with Yugor Strait by the middle of January.

FIG. 25—The ice that barred approach to the south coast of Nicholas II Land.

The winter was spent in overhauling the mechanism of the ships and, on the *Taimir*, in repairing the damage wrought by collision with the ice. Systematic meteorological and hydrological observations were made. The meteorological observations included exploration of the higher regions of the atmosphere by means of flying kites with a meteograph. Thanks to the perseverance of Lieutenant N. Evgenov, these observations were carried out continuously in spite of all obstacles, even during the polar nights. Observations of the ice were in charge of Lieutenant A. Lavrov. The cartographic work was under the able and enthusiastic direction of Lieutenant Neupokoev.

In addition to the regular work carried on the usual recreations of an Arctic wintering were indulged in, but the harsh weather together with the uncertainty about the war had a depressing effect on the personnel. Encouragement, however, was derived from the conversations with the experienced commander of the *Eclipse*.

Arrangements were made to take care of all eventualities. It was decided that should a second wintering be necessary, the expedition, provided with food for one half of its personnel, should transfer the second half to the *Eclipse;* this half was then to proceed over the tundra to the mouth of the Yenisei River, nearly a thousand miles away. Such a journey was, in fact, carried out. In case of wreckage of the vessels, it was planned that

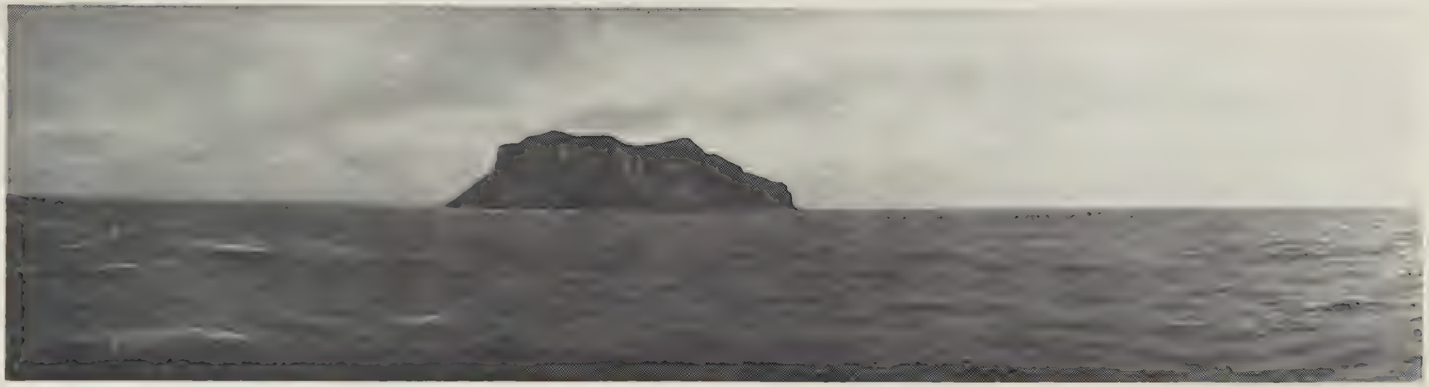

Fig. 26

Fig. 27

Fig. 26—General Vilkitski Island, discovered by the expedition on August 20, 1913.

Fig. 27—Preobrazhenie (Transfiguration) Island at the eastern entrance to Khatanga Bay. The delineation of the coast line of the bay has been greatly changed as a result of the expedition's surveys.

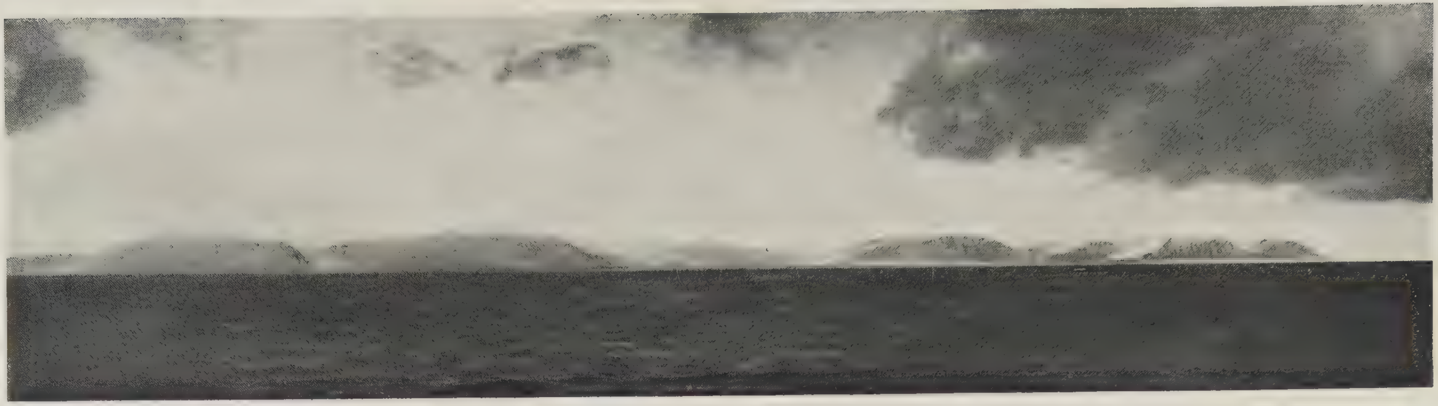

FIG. 28

FIG. 29

FIG. 28—The bold cliffs of the eastern coast of Nicholas II Land.
FIG. 29—The entrance to Pronchishcheva Gulf. Sand spits in the foreground. This inlet, which runs at least 25 miles into the interior, was not shown on any existing map.

the remaining half of the expedition should make for the mouth of the Yenisei River and establish a winter base in Dickson Bay.

Meanwhile supplementary measures were taken by Petrograd. In the first instance, a relief party was sent to assist the men in reaching the village of Golchikha, 750 miles from the place where the *Eclipse* was anchored for the winter. The organizer and director of this party was Begichev, boatswain of the *Zarya*, energetic, intelligent, and experienced.

FIG. 30—Ruined hut in Pronchishcheva Gulf, believed to be one occupied by Lieutenant Pronchishchev in charge (1725–1736) of the Lena-Cape Taimir section of Bering's second expedition. The situation and character of the structure and what could be learned from the natives through Begichev, leader of the relief expedition to the Yenisei, point to such a conclusion. The remarkable preservation of wood in the Arctic is well known.

In the second instance, a river expedition was despatched from Krasnoyarsk and down the Yenisei River; it took along portable wooden houses, provisions, and equipment for half the personnel of the *Taimir* and *Vaigach*, in case it should be necessary to spend the winter there. It was also provided with equipment for a radio station, which was to be in contact with Yugor Strait, and with coal for the vessels. The organizer and director of this party was Dr. Kushakov, a member of the Sedov expedition on the *St. Foka*, who, on Sedov's death, took his place and brought the expedition to a successful conclusion.

The two expeditions, thanks to their leaders, accomplished all that was required of them. Begichev's expedition was carried out in full. The buildings put up in Dickson Bay did not prove of much use, but the radio station and the meteorological stations were very useful during the war: in the absence of daily meteorological bulletins from abroad, the bulletins issued by the Dickson Station concerning the weather on the front took the place of those issued by the western countries.

By the middle of April a change of weather was noticeable; the first spring birds made their appearance. On May 12 Captain Sverdrup came to the *Taimir* and remained until the 19th, when he returned to his vessel with a party from the *Taimir* and the *Vaigach*. On July 5 Begichev reached the *Eclipse* with 650 deer, 200 of which were for the needs of the Samoyeds and their families, they being the owners of the herd. On the 15th Begichev and the party from the *Taimir* and the *Vaigach* left the *Eclipse* and

FIG. 31—The river discovered west of Cape Vilda.

started out for the mouth of the Yenisei, the deer carrying the freight. The journey was made in about a month and a half.

During May the tundra began to be enlivened by the presence of birds, and by the end of the month the temperature had risen to 3.6° C. The ice stopped increasing after it had reached a thickness of 150–200 centimeters, according to the thickness of the layer of snow upon its surface. From the middle of May to the beginning of July excursions to the land were inaugurated. An astronomical station was established on the coast, the customary beacon being erected. A survey of parts of the coast and its bays was made. During the preceding autumn the *Eclipse* had discovered the mouth of a new river west of Cape Vilda. Dr. J. J. Trjmeski and the writer undertook a sledge journey thither in June. The spring break-up had commenced, however, and it was impossible to stay for any further exploration. According to Begichev the river runs from the mountains south of the tundra and thus is of considerable length. The work carried out by Lieutenants A. Lavrov and N. Evgenov showed that Haffner Fiord is closed, disproving the previous supposition of a water connection with St. Thaddeus Bay on the eastern coast of the Taimir

Peninsula. A frozen mammoth with tusks eight feet long was found by one of the shore parties. For the shore excursions the hydro-aeroplane—which otherwise had proved useless—was converted into aero-sledges.

Between the 20th and 30th of July the first open spaces among the ice masses appeared, and the vessels began to drift. On July 28 the *Taimir* tried to free herself from the ice but without success. On August 8 openings appeared in the surrounding ice field, and two days later with the aid of an easterly wind the vessels freed themselves and, entering open water near the mouth of the Taimir River, started on their westerly course. At the entrance of the Nordenskiöld Archipelago the depths decreased considerably, and the *Taimir* ran aground. With the *Vaigach's* aid she was refloated. During this day a thunderstorm arose, a strange phenomenon in the polar regions.

Impassable ice now held the vessels back near the Vilkitski Islands. Not until August 27, after hard ice cutting, did they succeed in escaping to the westward. On August 28 the vessels passed Cape Vilda and on the following day met the *Eclipse*, which had freed herself on August 10 and had gone to Dickson Bay to get coal for the expedition's ships. In the meantime the steamer of the river expedition arrived in Dickson Harbor from Golchikha bringing news of the arrival there of the party from the vessels. The *Vaigach* proceeded to Golchikha and took the men on board. From Dickson Bay the *Eclipse*, the *Taimir*, and the *Vaigach* entered the Kara Sea, which was crossed without ice being encountered. The *Eclipse* then passed the Iron Gates, and the *Taimir* and the *Vaigach* proceeded through Yugor Strait.

On September 14 the vessels anchored at Cape Kanin, as they were instructed by radio not to enter the throat of the White Sea because mines had been laid there by German submarines. They met the ice-cutting ship *Brus* near the Cape and, escorted by it, arrived on September 16 in Archangel, where they were received with acclamation. The Northeast Passage had been made from the side of the Pacific Ocean, thus fulfilling the aim of the expedition—the exploration of the Great Northern Sea Road.

Conclusion

The war and the revolution have prevented the working up of the greater part of the scientific results of the expedition, especially the more interesting data pertaining to its latter years. It is, however, possible to draw some conclusions regarding the economic objective. It may be conditionally stated that the Northeast Passage is impracticable for commercial purposes. Even steamers of special construction would not make it if ice conditions were unfavorable. Favorable conditions depend in part upon high temperature in the summer, still more upon the occurrence of southerly winds: if such winds prevail, and especially if they are strong, the ice will break, and steamers can pass through; in the absence of such winds, they

FIG. 32

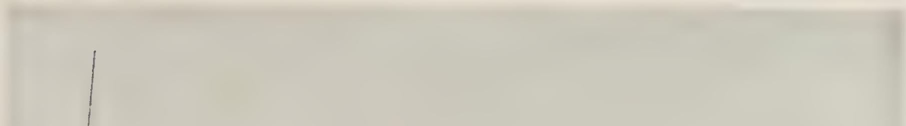

FIG. 33

FIG. 32—The *Taimir* in winter quarters off Cape Chelyuskin. Meteorological station on the ice.
FIG. 33—Dickson Harbor to the northeast of the Gulf of Yenisei. The wireless and meteorological station erected here proved of great use during the war.

cannot. This condition applies primarily to the region of Cape Chelyuskin, where, through the discovery of the new land to the north, there has been shown to exist instead of free water a strait only 50 miles wide, with islands in the middle and an archipelago of islands to the west.

Unfavorable ice conditions were observed by the expedition in 1913–1914. On the other hand, the *Vega* (1878–1879), the *Fram* (1893), and the *Zarya* (1901) enjoyed on the whole good conditions. The *Zarya*, during the preceding year, had been compelled to winter at the Nordenskiöld Archipelago where, in 1915, the *Taimir* and the *Vaigach* had broken through to the west with great difficulty. Amundsen in the *Maud* was compelled to winter twice in making the Northeast Passage in 1918–1920, first at Cape Chelyuskin, secondly off Chaun Bay.

We may, however, regard this question of navigability from another viewpoint—the utilization of the separate sections into which the route is naturally divided. These are: from the Kara Sea to the Kjellman (Minin) Archipelago; from the Kjellman Archipelago to Cape Chelyuskin; from Chelyuskin to the mouth of the Lena River; from the mouth of the Lena to the mouth of the Kolima River; and from the Kolima to Cape Dejnev.

The Kara Sea section, into which empty the powerful rivers Ob and Yenisei, presents during a certain period of the year, short though it is, favorable conditions for navigation and is passable. This section is of considerable economic importance.

The next region trends considerably to the north, is surrounded by islands and by an archipelago of islands which hinder the breaking up of the ice, and does not receive the discharge of rivers powerful enough to influence the ice. In consequence it is unfavorable for navigation. On the other hand it presents much of scientific interest.

The next region can be considered as a section by itself along the littoral, or as part of the passage to Cape Dejnev by way of the New Siberian Islands or Bennett Island. The varying ice conditions, which sometimes held back the expedition in this section, lead to the conclusion that it is not accessible and is risky for ordinary vessels. The littoral part trends sharply south with shallow waters, due to deposition from the Khatanga, Anabara, and Olenek Rivers. The northern part remains to be explored: various indications point to the existence of islands here, though this was not confirmed by the expedition of 1913–1914.

The region from the Lena to the Kolima is favorable as regards ice conditions because of the influence of the Lena, Yana, and Indigirka Rivers, but for the same reason it is shallow. This region is navigable.

The region from Kolima to Cape Dejnev is in a lower latitude and is easy of access. It is navigable but only from the beginning of August, when it frees itself from ice on the line from North (Syeverni) Cape to Wrangel Island. Its economic rôle in relation to the Yakutsk region is similar to though less important than that of the Kara Sea in relation to the basins of the Ob and Yenisei.

It should further be remarked that the waters off the Siberian coast are extremely rich in animal life – especially walrus and whales (near Bering Strait); the rivers and their mouths are also rich in fish, including some highly esteemed kinds. Coal, graphite, gold, and silver have been found in many places in northern Siberia; the Chukotsk Peninsula, according to geological opinion, is related to the Alaskan Peninsula, from which it is separated by a strait of about thirty miles, and contains the same natural resources as Alaska;[6] but here and westward, along the entire Siberian coast, the potential wealth can only be guessed at for lack of adequate knowledge.

APPENDIX

Notes on the Map

The compilation of the map is based on:

1. The work of the Russian Hydrographical Expedition to the Arctic Ocean, 1910–1915 (from Cape Dejnev to the meridian 99° E. from Greenwich, Russian H. O. Charts Nos. 984, 985, and 986, of 1923).
   From the meridian 99° E. from Greenwich to the west, data obtained by the Russian Hydrographical Expedition in 1915 on its way from the wintering place to Archangel are not shown on the new charts. Also very little is shown on Chart No. 986 of the strait between the mainland and Nicholas II Land, where in search of a passage to the west in 1914 the expedition spent over three weeks maneuvring across the strait, making landings on the southern shore of Nicholas II Land and Fernley and Heiberg Islands and taking many soundings.
2. Lieutenant A. V. Kolchak's work on the *Zarya* expedition 1900–1902 (from the meridian 99° E. to Dickson Harbor), Russian H. O. Charts Nos. 712 and 681.
3. The work of other Russian hydrographic expeditions (from Dickson Harbor to Archangel), various Russian H. O. charts up to 1916 with some additions and corrections up to 1924; latest British and United States charts.
4. Lieutenant G. L. Brusilov's polar expedition; Russian H. O. Records of 1914, Vol. 38, Issue I.
5. The map of Alaska (1:1,250,000) prepared by the American Geographical Society for the Alaska Road Commission, 1923.

Drift and soundings of the *Jeannette*, the *Fram*, the *St. Anna*, and the *Karluk* are taken from the respective official reports. The route of the *Maud* is not shown because no soundings were available; her survey of the two fiords of Thaddeus Bay in 1918–1919 has been made use of (H. U. Sverdrup: Maud-ekspeditionens videnskabelige arbeide 1918–19 og nogen av dets resultater, Separate from *Naturen*, January–April, 1922, pp. 5–88; map on p. 11).

Maps of Novaya Zemlya showing the results of Lieutenant Sedov's expedition, 1912–1914, have not been available to the author.

Franz Josef Land is drawn from the British Admiralty Chart No. 2282; and it is doubtful if the results of the Sedov expedition, which wintered in 1913–1914 near Cape Flora, were used.

The soundings taken by the *Eclipse* on her way from Lieutenant Khariton Laptev Land to Lonely Island and back to Dickson Harbor were not available.

In plotting the routes of the expedition, use was made of available soundings. No log books or other documents were available with the exception of photographed

[6] A. H. Brooks: The Value of Alaska, *Geogr. Rev.*, Vol. 15, 1925, pp. 25–50.

sketches of the routes of 1912 and 1913. In consequence the routes as shown are subject to revision and correction. Where confusion would arise through crowding of lines, details have been omitted and the routes generalized.

Astronomical observation stations are shown on the map. In order from east to west they are: C. Dejnev, C. Serdtse Kamen, northeast of Kolyuchin Bay, C. Onman, west of C. Syeverni, C. Billings, east of C. Kiber, C. Shelagski, C. Medvyeji, southeastern extremity of Chetirekh-Stolbovoi I., southeastern extremity of Krestovski I., Wrangel I. (between C. Thomas and Blossom Pt.), C. Titki, Blijni I., C. Svyatoi Nos; north coast of Mali I., southern extremity of Stolbovoi I., southeastern extremity of Jokhov I., C. Paks, Pronchishcheva Gulf, St. Andrew I., western island of St. Samuel Is., east coast of Nicholas II Land, west coast of Taimir Peninsula (near winter quarters of ships).

Icebergs

In the entire stretch of ocean from Cape Dejnev to Cape Chelyuskin and farther westward the expedition encountered icebergs only in the vicinity of Nicholas II Land. Icebergs were met here in 1913 at the southeastern end of the land, here aground in 70 fathoms of water, and at the northern end, and in 1914 tabular and other forms of icebergs were met at the southwestern end of the land aground in 20 fathoms.

It is impossible to state definitely the place of origin of these bergs as there are almost no data concerning the currents in the waters of the broad continental shelf from Cape Dejnev to Novaya Zemlya.

Glaciers of Bennett Island give rise to icebergs, but they are quite insignificant; the eastern coast of Nicholas II Land has glaciers giving rise to bergs on the eastern shore. Nothing is known of the western coast of the land.

The simplest solution is to suppose that the icebergs met were the product of the known glaciers of Nicholas II Land, those icebergs seen at the southwestern end of the land having been drifted there from the eastern shore by the resultant forces of still unknown deep-water and superficial local currents and predominant winds. The comparatively insignificant size of the icebergs is in harmony with such a hypothesis. It is also conceivable that the western shore of Nicholas II Land has glaciers and that the icebergs seen at the southwestern end of the land had been drifted from there by opposite forces of currents and wind.

But, extending the question beyond these local limits, another supposition may be reached. Schokalsky, in his well-known treatise on oceanography[7] says that "the more northerly branch of the North Cape Current would seem to reach the northern shore of Novaya Zemlya, a portion passing between that island and the archipelago of Franz Josef to latitude 80° N. which it would seem to double from the east; by its mass of water this is the strongest branch of the North Cape Current."

The North Cape Current itself, as is known, is a branch of the North Atlantic Drift, and the other and stronger branch of the same current, the so-called Spitsbergen Current, passes along the western shore of Spitsbergen, doubles its northern end, and constantly sinking deeper beneath the colder but fresher and less dense waters turns to the right, i. e. to the east, in consequence of rotational deflection.

Could we not attribute a similar easterly deflection to the northern branch of the North Cape Current rather than suppose a route to the north along the eastern shore of Franz Josef Land?

We can then imagine that icebergs of the southern shores of Franz Josef Land or even off the eastern shores of Novaya Zemlya immersed 50 meters and more

[7] J. M. Schokalsky: Okeanografia, Petrograd, 1917 (reviewed in *Geogr. Rev.*, Vol. 14, 1924, pp. 679–680). See also the map, North Polar Sea, Pl. I, in "Meteorologii i okeanografii Karskago i Sibirskago morei," Petrograd, 1918. For a photostat copy of this latter work the American Geographical Society is indebted to M. Stanislas Reizler, librarian of the Société de Géographie, Paris.

would come under the influence of that deep-water current and would drift along the continental shelf to Nicholas II Land. This hypothesis is not contradicted by the drift of the *St. Anna*, which indicates the direction of the *superficial* current of the Kara Sea under the influence of the waters of the Ob and Yenisei and of the predominant winds.

There are analogous examples. The presence of great bergs at the western shore of Novaya Zemlya has frequently been observed,[8] and their origin from Spitsbergen or Franz Josef Land is deduced on the ground of their size, which surpasses that of the bergs from Novaya Zemlya. At the same time a cold superficial current carries ice from Franz Josef Land to Bear Island, and the existence of another cold superficial current to the north along the western shores of Novaya Zemlya and in the strait between that land and Franz Josef Land is suggested by the drift of the *Tegethov* to the north.

As to the superficial currents of the Kara Sea itself and also the current of the strait between Novaya Zemlya and Franz Josef Land, the deflection towards the east on the parallel of Cape Jelaniya in the drifts of the *St. Anna* and the *Tegethov* suggests the influence of the North Cape Current. But such influence on the ice fields and drift of ships is naturally less than the forces determining the direction of the superficial current; while for the icebergs, on the contrary, the influence of the deep-water current is greater than other causes.

The above suggestion, however, is offered as a mere hypothesis. The question calls for study with all available material.

Hypothetical Lands: Sannikov Land and Andréev Land

Complete historical data concerning Sannikov Land are found in "Die Russische Polarfahrt der *Serja*, 1900–1902," including the diaries of Baron Toll, head of the expedition, found by Lieutenant A. V. Kolchak on Bennett Island. Briefly, the account is as follows. In 1805 the hunter-trader, Jacob Sannikov, saw a land to the north from the northern cape of Kotelni Island. The next year he also saw land to the north from Novaya Sibir. As the existence of the latter (Bennett Island) was subsequently proved by Lieutenant De Long, Sannikov's claim could not be dismissed by Baron Toll notwithstanding the negative result of the extensive explorations made by Lieutenant Anjou in the twenties of the last century. In 1886 Baron Toll, during his first expedition to the New Siberian Islands, says that he himself saw from the northern end of Kotelni Island land lying 14°–18° to the northeast. He estimated the distance of this land as a degree and a half or two degrees from the northern end of Kotelni Island. But it was not seen by Baron Toll himself from the extreme point reached by him in 1901 on the *Zarya* somewhat south of the supposed position of this hypothetical land, nor was it seen by our expedition of 1913, the route of which crossed this region a degree and a half north of Kotelni Island, nor was land observed to the south of this point by the expeditions of 1913 and 1914. If it exists it must be looked for farther to the north and, according to the drift of the *Fram*, probably to the east also.

As to Andréev Land, seen by Andréev in 1763, there are no positive data about it except his own statement. On the contrary, all observations up to Wrangel's inclusive suggest a negative solution of this problem.

Briefly the story of this land is as follows.[9] Plenisner, a member of Commander Bering's expedition in 1741, traveled to the Anadir peninsula by order of the Governor of Siberia to determine the possibilities offered for settlement. From its Chukchi inhabitants he learned that a great land lay north of the Kovima (later Kolima) River, called Imoglin, and to its discovery he despatched Sergeant Andréev.

[8] See, for instance, A. E. Nordenskiöld: The Voyage of the Vega (2 vols., London, 1881). Vol. 1, p. 182.

[9] V. N. Berkh: Chronological History of All the Travels to the North Polar Countries, St. Petersburg, 1821.

Andréev left Nijne-Kolimsk in March, 1763, and on April 22 entered the Arctic Sea from the Krestovaya River, whence he reached the Bear Islands. He saw nomad tents everywhere; and on the eastern part of the horizon, somewhat to the north, he saw "blue,"[10] but he did not *assert* it was land. Lacking food for his dogs he returned to Nijne-Kolimsk. Berkh supposes that Andréev made a second journey in 1764, for in the supplementary article of the instructions to Captain Billings, 1787, it is mentioned that from the farthest of the Bear Islands Andréev saw a far-away land to which he started, but at 20 versts' distance from it he noticed signs of a multitude of deer-riding people and, having few men with him, returned to Nijne-Kolimsk.

Andréev's statements were in part responsible for the organization and despatch of a series of expeditions from 1767 to 1823—Leontiev, Lissov, and Pushkarev in 1767–1769, who described the Bear Islands; Captain Billings in 1787; and Wrangel in 1821–1823.

Various northern latitudes reached by these expeditions gave no confirmation of the existence of such land. The *Jeannette* drift bounds the possible position of this land on the north.

Judging from the fragmentary data available, the drift of the *Maud* in 1920–1923[11] from Wrangel Island to the northwest was generally parallel with that of the *Jeannette* but on the average 50 miles south of it, whereby this area, together with the route of our expedition in 1911–1914 bordering its southern and western boundaries, has been still more contracted.

However, the fact that constant efforts of our expedition to get into that unknown region from the southeast, south, and west invariably met obstacles in the form of heavy and absolutely impassable ice (see the map) strengthens the possibility of the existence of land, and the problem remains open.

In addition to the drifts of the *Fram*, the *Jeannette*, and the *Tegethov* we have now the drifts of the *St. Anna*, the *Karluk*, and the *Maud*—the last unavailable in detail. It would be interesting to study the zigzags of all these drifts on the basis of hydro-meteorological data with a view to determining the connection, if any, between these zigzags and adjacent lands.

The ocean depths east of the New Siberian Islands are quite unknown. The few depths surpassing 50 meters to the north and southwest of Wrangel Island and on the meridian 160° E. do not permit us to draw any conclusions as yet.

If the observations of the flight of birds from the north, made by our expeditions, give further suggestion of the possibility of land in that region, on the other hand the *polynija* (see footnote 10), channels of open water often seen here in winter, offer evidence of a contradictory nature—that the ice is in movement here during the winter, i. e. that this region is in touch with the polar ice pack and outside of the land-fast ice. The drift of the *Maud* newly confirms the drift of the *Jeannette* in this respect and shifts still farther south the northern boundary of the land-fast ice.

The invariably heavy accumulation of ice in the southern part of the region observed by the expedition may be explained either on the supposition of the shoaling of the sea bottom in the middle of this region within the limits of 50 meters depth, or on that of the existence of some local superficial current which might explain the origin of the ice fields as well as the accumulation of ice.

However this may be, the region remains one of the unexplored areas along the northern coast of Siberia.

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[10] Evidently a reflection of the *polynija*, the channel of more or less open water that separates the land-fast from the moving ice. On the *polynija* in this region and elsewhere in the Arctic Ocean see J. Schokalsky: La circulation dans les couches superficielles de la mer polaire du Nord, *Ann. de Géogr.*, Vol. 33, 1924, pp. 97–104.

[11] *Geogr. Journ.*, Vol. 65, 1925, pp. 84–85.

THE PROGRESS OF SURVEY AND SETTLEMENT IN BRITISH COLUMBIA

By George G. Aitken
Department of Lands, British Columbia

The year 1857 marked the conclusion of the first stage of white settlement in British Columbia. At this time Victoria, the chief center, was a little hamlet of a few hundred people, chiefly retired Hudson's Bay Company servants. The chief interest in the region lay in the fur trade, carried on during the preceding half century both along the shores and in the interior.

Captain Cook's voyage of 1778 had prompted several expeditions in search of the wealth in furs, mainly sea otter skins, along the north Pacific shores of the continent. Of these expeditions the most important in political geography was that of Captain John Meares in 1786 from China to the coast of Vancouver Island. Trouble with Spain caused by the arrest and imprisonment of Meares, a British subject, attracted particular attention. In 1792 Captain Vancouver was sent by the British government to attend the formal apology of the Spaniards at Nootka, and in the course of this duty he made a survey of the coast from Juan de Fuca Strait to the Queen Charlotte Islands. This is the first reputable survey of the coast of British Columbia.

First Knowledge of the Interior

Simultaneously, the exploration of the interior had been begun with the intrepid journey made by Alexander Mackenzie from Athabaska through the Peace River country, up the Parsnip River over the height of land, and down to the Fraser. He was the first white man to view the Fraser, the drainage basin of which occupies about one-fourth the area of the country; and his was the first overland journey to the Canadian Pacific coast. Other notable names followed—John Stuart, Simon Fraser, David Thompson, and the like. Their explorations, prosecuted on behalf of the great fur trading companies, culminated in the exploitation of the Pacific seaboard even as far south as California. At one time the Hudson's Bay Company had a post at San Francisco with the Spaniards and even a station at Hawaii.

In 1846 the signing of the Oregon Treaty determined the southern boundary of British territory. Three years later Vancouver Island was given the status of a colony, and a governor was appointed—an event which "portended the early elimination of the fur trader's sovereignty and was at least the outward and formal sign of the establishment of British suprem-

acy and British institutions on the North Pacific coast."[1] The Hudson's Bay Company's rule in Vancouver Island terminated in 1858, at which time their license of exclusive trade on the mainland, vaguely known as "New Caledonia," was revoked. At the same time the mainland was created a colony under the name of British Columbia.

Development through Mining

The changed outlook for the region was emphasized and progress accelerated by the discovery of gold on the Fraser River in the year 1858. The pathways in the interior which had been sufficient for the fur trade were inadequate for the requirements of mining. New trails were built and routes established. The miners, in their hunt for gold, penetrated as far north as the tributaries of the Peace and Finlay Rivers and southeastward into the Kootenay area; so that knowledge of the interior of the country, previously confined to the Indians and a few men of the Hudson's Bay Company, became general.

As this knowledge and development of the country had taken place through mining activity, the laws and regulations of the period were drawn up with the primary view of fulfilling mining requirements and encouraging development. The recording and partitioning of claims logically followed and, with this, the necessity for precise surveying of land and mineral boundaries. It is an interesting fact that the California placer miners originated the general form of the placer mining laws of British Columbia and that the miners from Montana and Colorado inspired the British Columbia lode mining laws, which were later improved.

With the advent of gold seekers, James Douglas, governor of Vancouver Island, asked the British government for a military force to support his administration and protect property rights. A company of sappers and miners of the Royal Engineers, under the command of Colonel R. C. Moody, was sent out. The members of this Company represented most trades and professions, and their duties were to cover three phases—that of assisting to maintain law and order, surveying of land boundaries and roads, and construction of roads and buildings. Colonel Moody was the first Chief Commissioner of Lands and Works of British Columbia. The earliest recorded survey under his direction was in 1859 for land settlement of what is now the city of New Westminster. In 1860 the Royal Engineers selected and surveyed a trail from Port Hope to Similkameen, known as Dewdney Trail. In 1861 they made surveys for portions of the road through the Fraser canyons, which became the route of the Cariboo wagon road and, later, surveyed lands of the lower Fraser valley. Surveys were made also of other possible routes into Cariboo and of what became the upper portion of the Cariboo wagon road. The surveys undertaken were those required

[1] Canada and Its Provinces, edited by Adam Shortt and A. G. Doughty (23 vols., Toronto, 1914), Vol. 21, pp. 91–92.

for the immediate needs of transportation to the mines, and gradually sections were surveyed for agricultural purposes, mainly areas adjacent to the Cariboo wagon road and to the mining camps. Owing to the rugged structure of the country—that of valleys between high ranges—land surveys were confined to isolated patches as the choicest, easiest, and most accessible portions became settled.

FIG. 1—Sketch map of British Columbia showing the localities mentioned in the text. Scale 1: 14,000,000.

Progress through the Railroad

The Vancouver Island colony was merged with the mainland colony in 1866, and in 1871 the united British Columbia entered the confederation of provinces constituting the Dominion of Canada. A provision of this union with the Dominion was that a railway be constructed to connect British Columbia with the Canadian railway system and secure the completion of such railway within ten years from the date of union. The carrying out of this agreement brought about the third phase of geographical knowledge in British Columbia. The search for the best railway route necessitated careful survey reconnaissance for direction and difference of elevation through the Rocky Mountains and westward to the coast. The route finally chosen for construction was through the Rocky Mountains

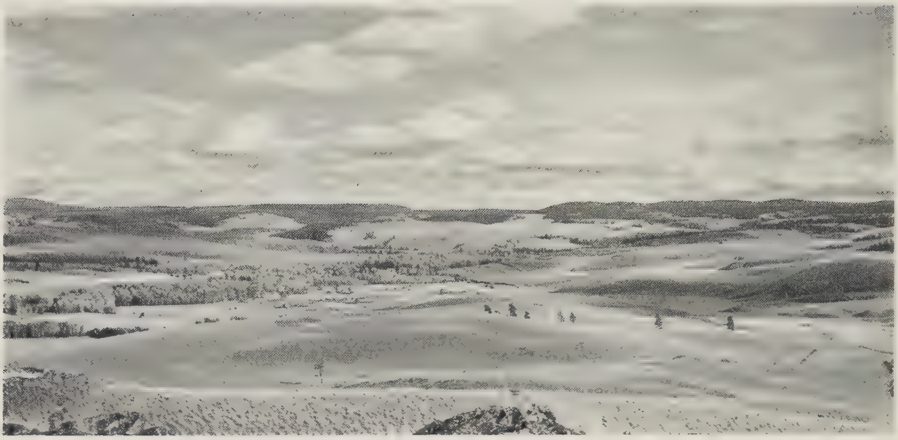

FIG. 2—In the southern interior plateau. The Nicola River valley.

via Kicking Horse Pass, thence through the Selkirks, down the Thompson and the Fraser Rivers, and westward along the line of the Canadian Pacific railway as it exists today. Until the completion of the international boundary line survey between British Columbia and the United States, the Canadian Pacific railway line survey formed the only reliable continuous survey connecting British Columbia coast surveyed lands with the survey system of the prairie provinces of eastern Canada.

Following the construction of the Canadian Pacific railway, with its transportation facilities, other surveys were made for railway projects, especially in southern British Columbia, to exploit the coal and land areas and the silver, copper, and lead mines. With this railway expansion land settlement and mining activity went hand in hand.

Land settlement so far had more or less followed general development of the mining. At this period the attraction of the lands thrown open in the United States in great areas had been felt by the mass of land seekers. Towards the end of the last century, when the settlement of Canadian prairie lands was undertaken in a systematic way, interest was also directed to available lands in British Columbia. Since the early years of the twentieth century, there has been increasing demand for information concerning these lands.

Land locators "preëmpted" (located) large areas of the interior lands, more especially those contiguous to the route surveyed for what is now the Canadian National railway line, between Yellowhead Pass and Prince Rupert. These located lands were afterwards surveyed according to the provincial survey system then in force.

Physiographic Divisions

The boundaries of British Columbia, those constituted in 1866, inclose an area of 372,630 square miles. The populating of this vast area has pro-

FIG. 3—Range land, Nicola. (Photographs 2 and 3 by R. D. McCaw.)

gressed apace—from 36,247 in 1871 to 524,582 in 1921, an average annual increase of 9767 persons. The major population is concentrated on the coast and valley lands of the southwesterly and southerly portions of the province. The urban population is 47 per cent of the total; the rural 53 per cent, the density in the latter case being 74 persons to the square mile. The problems that confront settlement can be appreciated by a glance at the topography. A careful computation gives the land below 2000 feet as 25 per cent of the entire area.

A part of British Columbia lies to the eastward of the Rocky Mountains. This area, which includes portions of the drainage basins of the Liard and Peace Rivers, is an undulating plateau country some 105,875 square miles in extent and of altitude varying from 1400 to 3500 feet above sea level. The term Rocky Mountains embraces a series of rugged peaks and ranges. Towards the southeast the mass has considerable width with peaks ranging up to and over 11,000 feet in altitude. From Mt. Robson, 12,972 feet (Interprovincial Boundary Survey) high, the breadth and height of the mountains lessen until they merge into the upland rolling country of the north-central portion of the province.

Between the Rocky Mountains and the Coast Range is the Interior Plateau, so called, a region of great diversity including many fertile valleys and benches. The Interior Plateau falls into two divisions roughly defined by the water parting between the Fraser and the Skeena and Peace Rivers. The northern interior portion of the province is of the undulating type interspersed with prominent peaks and ridges. With the exception of mining activity at Hazelton, Stewart, Telegraph Creek, Atlin, and other points, and the agricultural development in the Peace River area, the northland beyond the immediate neighborhood of the Canadian National railway (Yellowhead Pass to Prince Rupert) remains to be developed. It is still the domain of the fur trader and the prospector.

The highest point of the Coast Range in the south is nearly 100 miles from the sea; northward the western watershed broadens considerably, but the fiords reach even to within a few miles of the height of land. Considerable areas of the Coast Range have never been traversed. Apart from the lofty section at the northern limits of British Columbia (Mt. Fairweather, 15,827 feet, is partly within the province) there are no known peaks as high as some of those of the Rocky Mountains: however, as many of them rise from sea level to heights of 6000 to 9000 feet, they present a spectacle equally imposing.

Vancouver Island and the Queen Charlotte Islands are plateau-like remnants of a sunken range. The westerly and northern parts of Vancouver Island are still covered by primeval forest of large timber; in the south and east are rich valley and coast lands. The western face of the Queen Charlotte Islands likewise is rugged in character, but in the east of Graham Island there are considerable lowlands.

Land Tenure and Classification

British Columbia having been originally a British Crown Colony, all the lands of the province are vested in the Crown (in the right of the province). Under terms of confederation, for building of railways, the British Columbia government transferred to the Dominion government an area twenty miles wide on each side of the line of the Canadian Pacific railway, known as the Railway Belt; an area known as the Peace River block; and the easterly section of Vancouver Island, known as the Esquimalt and Nanaimo railway grant. This latter is administered by the railway company, the other two being administered by the Dominion government.

Provincial lands not already taken up may be obtained by purchase—first-class land for five dollars an acre, second-class land for two dollars and fifty cents an acre—or, vacant surveyed lands, by preëmption (homesteading). The purchaser or preëmptor obtains title by crown grant in perpetuity under the terms of the Provincial Land Act.

The principal areas of surveyed lands now open for preëmption are on the mainland, north of the Railway Belt, and are contiguous to the Canadian National railway, from Tête Jaune to Prince Rupert and along the North Thompson River, and to the Pacific Great Eastern railway.

The area of the province transferred to the Dominion government up to 1923, including the Esquimalt and Nanaimo railway grant, was 26,393 square miles. The provincial surveyed lands of the first and second class, open for preëmption and purchase, comprise to the end of 1923, 4,760,819 acres. Although an estimate has been published[2] of the agricultural (crop) land (1917) as 20,000 square miles, it is in fact too early to determine the percentage of land in British Columbia which ultimately will become agricultural land. The productive forest land is estimated (1917) to be 144,000

[2] H. N. Whitford and R. D. Craig: Forests of British Columbia, Commission of Conservation, Ottawa, 1918.

FIG. 4—Meadow Lake and Pass on the Great Divide, latitude 53° 35′ N. (Photograph by Interprovincial Boundary Commission.)

square miles, including an area of merchantable-size timber of 29,000 square miles. The grazing area of the province is estimated at 60,000,000 acres of open grazing land and 100,000,000 acres of timbered grazing land. At present only about 10,000,000 acres are being utilized in the province for this purpose.

The Land Act defines meadowland as first-class land and other lands (except timber lands) as second-class. In former years this classification was left to the decision of the land surveyor surveying the lands. Of recent years the survey regulations call for "surveyor's report on examination" describing timber, surface, soil, vegetation, water supply, roads, location, elevation, climatic conditions, and farming suitability.

Surveying

The system of survey used in the prairie provinces of Canada and in the western United States—that of ranges and townships—to define farm and timber lands, was considered unsuitable for the physiography of British Columbia. The farm lands and timber areas in British Columbia occur in the wide valleys, bench lands, and plateaus, these being separated by mountains and ranges.

With few exceptions the farm lands have been laid out in areas of a mile square, a half, or a quarter and are called land lots, being surveyed by transit and chain (66 feet to a chain) giving sides of 80, 40, or 20 chains. Each land lot has been oriented to true north. These surveys were not laid out in any regular pattern but simply followed the choice pieces of land as they were selected or preëmpted.

The survey of the timber lands was made under similar regulations as to length of sides and orientation true north, but only by compass for direction and chain for distance. These collections of surveys might be tied together within each local area, but there was no attempt made to correlate them as a whole except in the southern part of the province where large railway block surveys made it possible in a few instances to tie the provincial surveys to the geodetic survey of the international boundary along the forty-ninth parallel.

From the opening years of the twentieth century to 1914 intense public pressure for surveys of agricultural and timber lands in the central and northern interior was a further cause of unrelated surveys.

The provincial surveyed areas were plotted in plan, singly in most cases, on the official maps. So long as the collections of surveys were well apart from one another, the fact that the earth is a spheroid, whilst these were constructed square without any correction for curvature and plotted in plan, did not give difficulty. As the surveys multiplied and one collection of surveys joined another collection, overlapping of boundaries was a natural outcome. Also it was impossible to plot long strings of lots having no major control, without cumulative errors and confusion as to geographical position.

FIG. 5

FIG. 6

FIG. 5—Mt. Robson region of central Rocky Mountains. Glacial source of a headwater stream of Smoky River, tributary of Peace River. (Photograph by Interprovincial Boundary Commission.)
FIG. 6—The Coast Range from the head of Whitesail Lake. (Photograph by Bureau of Mines, B. C.)

In such physiography the initial requirement for a system of survey would be that of a primary triangulation of geodetic survey accuracy, with belts of secondary or tertiary triangulation linking and controlling the land and timber surveys of the valleys and plateaus.

The first tangible effort to correlate the provincial surveys was made in 1912, when base lines along certain meridians and parallels were surveyed as fixed boundaries of certain land districts. Determination of geographic position for these base lines was made by the Astronomical Branch of the Dominion government.

The international survey defining the forty-ninth parallel of north latitude and the boundary between Alaska and Canada form a reliable major control. The latter survey is being extended southward along the coast to meet the former. Since 1917 a triangulation of the coast line in all its intricacies has been made by the provincial government, whilst the survey of the boundary between Alberta and British Columbia is almost completed.

The dominion government surveys along the Dominion Railway Belt—which for the most part have depended upon the computation of a precise single line traverse survey, are gradually coming under a connected triangulation.

The provincial government has extended triangulation belts from the original meridian and parallel surveys of the interior to the coast and northward. Also, wherever possible, tie traverses have been run to connect the isolated surveys.

A forward step in the evolution of the surveys was the installation a few years ago of a standard base map system. As the long chains of surveys became connected, main "routes" (or traverses) along already surveyed lines were selected. These, being chosen to connect with astronomical or geodetic positions, could be balanced, and secondary geographical positions established therefrom.

By carrying out this system it has been possible to evolve main control routes through the various valleys linked to triangulation wherever such is available, and to define geographical positions within all the main areas with a fair degree of accuracy.

Lode mining properties are known as mineral claims and are surveyed by transit and chain in squares of fifteen hundred feet. They are oriented in whichever direction the mineral lead occurs. Mineral claims occurred in separate collections. In the southeastern part of the province there was an effort made to link these to mineral monuments established by triangulation; but, owing to the fact that mineral areas were widely separated, this scheme was not extended. Of recent years these mineral claim surveys have been tied by survey to the land and timber surveys.

Topographic Surveys

In addition to the line surveys just described, many areas of geological interest have been topographically surveyed by the Geological Survey of

FIG. 7

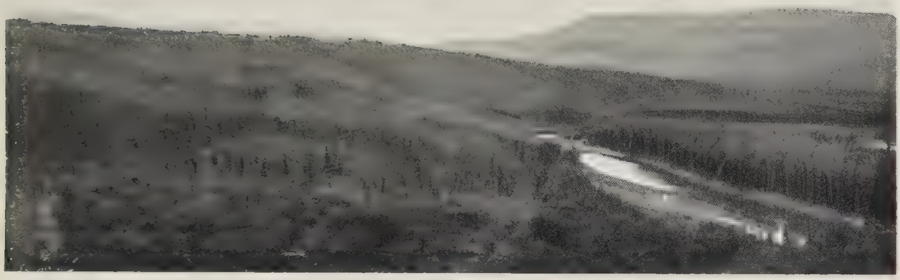

FIG. 8

FIG. 9

FIG. 7—In the northern interior. Looking up the Spatsizi River (Stikine River basin) from forks easterly. (Photograph by Bureau of Mines, B. C.)

FIGS. 8 and 9—In the northeastern section. The valley of the Sikanni River, one of the streams forming the Fort Nelson River. (Photographs by G. M. Milligan.)

Canada. The various boundary survey belts have been topographically mapped. The watershed and area lying to the west of the Okanagan Lake have been surveyed topographically to show relief by contouring. Considerable areas of the northern interior have been covered by topographical reconnaissance and mapped.

The standards of accuracy of these various topographical surveys are varied, the surveys being based on the type of topography, the economic value of the area, and the publishing scale of the proposed mapping. The principal method of survey applicable to the general type of physiography has been phototopography.

Comparison with the Northwestern United States

Comparison with the four northwestern states—Washington, Oregon, Idaho, and Montana—is interesting. British Columbia is approximately equal in area to these four states, and there are many similarities in physiography and natural resources. These similarities are clearly shown in the comparative geographical study, which is introduced in the commercial and visitors' sections of information appearing on the back of the new map No. 1K, British Columbia, South Western Districts, which has just been published by the Provincial Government.

The population of the four states was about 500,000 in 1885 and is now over 3,000,000. Roughly, it has taken forty years for their resources to attract and support 2,500,000 additional inhabitants. The present population of British Columbia is slightly over 500,000. Conditions now governing immigration suggest that in the next few decades growth and development similar to that of these four states will be experienced in British Columbia.

British Columbia, in addition to its own manifold natural resources, has the geographical advantage of being the seaboard province adjacent to the immense wheat and farming areas of the prairie provinces of Canada. British Columbia will be an important door of the corridor of British Empire and world trade.

AN EXPEDITION TO THE KALABIT COUNTRY AND MT. MURUD, SARAWAK

By Eric Mjöberg

Sarawak, that romantic land of the White Rajahs, reclaimed from piracy and head hunting and paying tribute to civilization even in its remotest corners, is still far from being fully explored. Especially is this true of the mountain chains, the watersheds of which divide the territory from Dutch Borneo to the south and east. The ranges of central Borneo have not yet been crossed since Müller's bold and ill-fated attempt in 1824,[1] and many lofty peaks would amply repay the ascent they await. Rising to altitudes of thousands of feet, these equatorial mountains offer an extraordinarily interesting field to the naturalist. There are, for instance, the centrally situated Mt. Tiban and its neighbor Mt. Bulan long known through native report. Nieuwenhuis, the well-known Dutch explorer, tried to reach Tiban in his famous overland journey but failed.[2] He managed to catch a glimpse of Mt. Bulan, which, however, soon wrapped itself in dense clouds as though anxious to keep its mysteries a secret. Dr. Nieuwenhuis estimated Mt. Bulan to be about 7000 feet high. Even if Mt. Tiban and Mt. Bulan should prove to be only 5000 to 6000 feet, they will still be of biological importance. To what extent we have a continuous mountain fauna and flora right through from Kinabalu in the north to Mts. Penrissen and Poi in the west, as well as certain mountain chains in the south and southwest of Dutch Borneo, remains yet to be proved. A proper biological survey the whole way through is needed before any definite statements can be made.

The accessible Mt. Poi (5000 feet) in the extreme west has been several times visited. I myself conducted an expedition thither and to the nearby Penrissen (4500 feet) in 1923 and gleaned a rich biological harvest.[3] At the other extremity of the British sphere is Mt. Kinabalu, the highest measured summit in Borneo (13,455 feet), known in part. All visitors, however, have gone the same way, leaving at least three-quarters of the great massif unexplored.[4]

History of Mt. Murud

Roughly midway between Kinabalu and Tiban lies Mt. Murud in the Kalabit country. Of the earlier explorers of Sarawak, Spenser St. John

[1] For an account of earlier exploration in Borneo see the excellent work by Theodor Posewitz: Borneo: Its Geology and Mineral Resources, transl. by F. H. Hatch, London, 1892.

[2] A. W. Nieuwenhuis: Quer durch Borneo, 2 vols., Leiden, 1904–07.

[3] Eric Mjöberg: Fourteenth Report on the Sarawak Museum, 1915–1920, Sarawak, 1924, pp. 27–28.

See also J. C. Moulton: Some Notes on a Short Collecting Trip to Mt. Poi, Sarawak, *Journ. Straits Branch Royal Asiatic Soc.*, No. 65, Singapore, 1913, pp. 1–12.

[4] J. C. Moulton: An Account of Various Expeditions to Mt. Kinabalu, *Sarawak Museum Journ.*, Vol. 2, 1915, pp. 137–176.

seems to be the only one who mentions Mt. Murud. Writing of his exploration of the Limbang River he refers repeatedly to a large mountain chain to the east.[5]

> The mountain at the southern end of the first eastern range, called by the natives Murud, or "the mountain," bears south-east by south, and in a straight line is perhaps not more than three miles off . . . started in a south-west direction for about a mile and a half, to the top of a hill, from whence there is usually a view of Lawi in a south-west direction: all the mountains, however, are hidden in clouds, but it must be a high one if remarkable among its towering neighbours. The whole appearance of the country is mountainous, each range becoming more lofty as we approach the hidden interior. From an elevation of about 4348 feet the two mountains next us looked very high, perhaps between 7000 and 8000 feet.

After St. John's days nobody seems to have tried to reach the interior parts of northern Sarawak until modern times. In 1906 (?) the former Resident of the Baram District, Mr. R. S. Douglas, undertook a journey to the western parts of the Kalabit country in order to establish peace and collect taxes.[6] He was apparently the first white man to visit these parts and to approach the Pamabo Range. In the sketch map accompanying his account it is called Mt. Pamabo and marked as an isolated mountain. Naturally his map is very much out of proportion. A mountain called Bt. (Bukit) Murud, southwest of his Mt. Pamabo, represents undoubtedly the so-called Murud Ketjil, or small Mt. Murud.

In 1911 Mr. Douglas undertook a second journey to the region and this time with better success.[7] He again followed the tributary of the Baram River, Tutau, but went much farther, climbing the Pamabo Range, penetrating the eastern and interior foothills of the Kalabit country, and establishing peace among the different tribes which up to the time of his visit had been constantly fighting with each other with only too great success in the taking of heads. On the sketch map accompanying this account we find for the first time "the eastern range" mapped as a continuous range running roughly north-south and terminated at the north by a mountain called Mt. Murud.[8] Another Mt. Murud occurs on his map much farther south, to the west of the southern end of the Pamabo range and in north-easterly direction from Lio Matu (Murud Ketjil).

On Douglas' map we find Batu Lawi placed due northwest of the first-mentioned Mt. Murud, whereas in reality and according to my own magnetic compass cross bearings, that unmistakable mountain is situated practically southwest with a slight tendency southwards. Mr. D. Owen, the

[5] Spenser St. John: Life in the Forests of the Far East, 2 vols., London 1862, reference in Vol. 2, pp. 126–128.

[6] R. S. Douglas: A Journey into the Interior of Borneo to Visit the Kalabit Tribes, *Journ. Straits Branch Royal Asiatic Soc.*, No. 49, Singapore, 1907, pp. 53–62.

[7] R. S. Douglas: An Expedition to the Bah Country of Central Borneo, *Sarawak Museum Journ.*, Vol. 1, 1912, pp. 17–29.

[8] On Posewitz's map accompanying his work cited in footnote 1 we find Mt. Murud laid down quite close to the Dutch border, with Batu Lawi slightly south of west. E. G. Gomes, in his "Seventeen Years Among the Sea Dyaks of Borneo" (London, 1911), probably on the basis of St. John's work, shows Mt. Murud farther away from the Dutch border and Batu Lawi due southwest of it—positions which entirely agree with my own bearings. He gives the height of Mt. Murud as 8000 feet, which also comes nearer the truth.

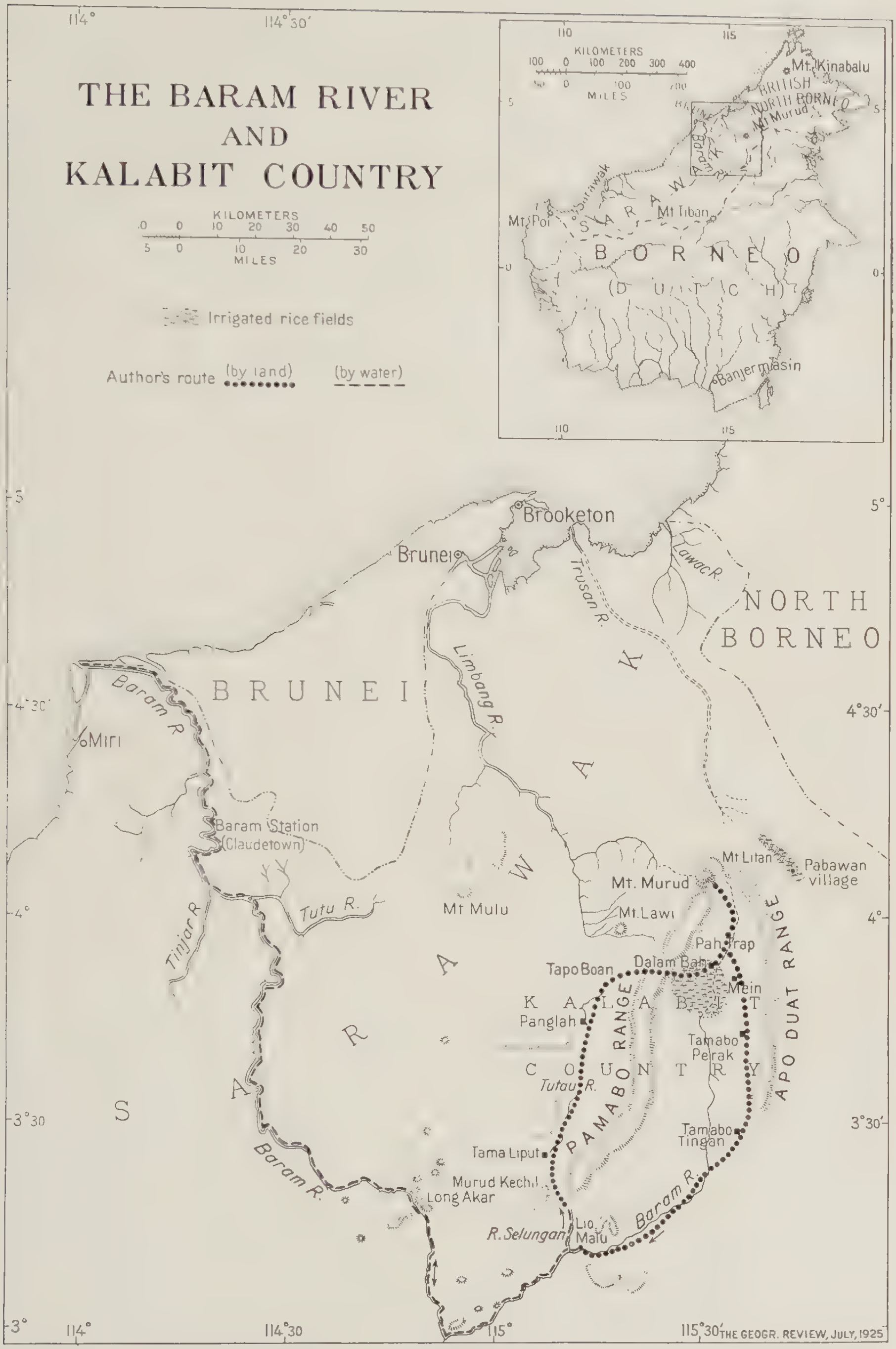

FIG. 1—Sketch map to show the author's explorations in the Kalabit country of Sarawak. Scale 1: 2,000,000. The inset map shows the general relations of the region.

present Resident of the Third Division, who some ten years or more ago made a trip to the Northern Bah country visiting the Pah Bawan people and walking round the northern end of the Pamabo Range for a good distance, corroborates my statement. Two other Europeans, Mr. Andrieni and Mr. Spurway of the Sarawak Civil Service, who visited practically the same region walking from the headwaters of Trusan River to the headwaters of Limbang River, also declare that they found Batu Lawi situated southwest of the big Mt. Murud and not very far from the western slopes of the Pamabo Range.

No data on altitude or other geographical features are given in Douglas' account, but due credit must be given him for having revealed two hitherto unknown facts: that the Pamabo Range extends as a continuous high range from north to south and that it is terminated in the north by a very high mountain, Mt. Murud.

In 1911 Mr. J. C. Moulton[9] undertook a journey up the Limbang River in order to explore Batu Lawi. It took him 28 days to get there and 16 days to return. He devoted only 24 hours to the exploration of this interesting region and did not even make an attempt to climb its two peaks.

A sketch map of the northern parts of Sarawak accompanies Mr. Moulton's report. It is seriously incorrect. Batu Lawi is placed more than 50 miles east-northeast of the Pamabo Range, whereas in reality it is situated on the western side of the Pamabo Range; and, whereas the Pamabo Range actually is a long continuous range running mainly south and north, Moulton shows it as a small chain running chiefly east and west.

The second European to visit the Kalabit country was the District Officer in Baram, Mr. C. D. Adams, accompanied by Dr. O. Luhn. Adams went there for the purpose of collecting taxes and for general reconnaissance. He crossed the Pamabo Range and went as far as to Pah Trap, from which point he returned by the southern way, probably using the same route and passing through the same villages as I did myself. Nothing has been published of this journey. Both Douglas and Adams are still well remembered among the Kalabits, and I found their names on everybody's lips.

The initiative for the exploration of Mt. Murud emanated from the Sarawak Museum in 1914. Its curator at that time, Mr. J. C. Moulton, set out in October for a long-contemplated expedition to the Kalabit country. He reached the first Kalabit village at the head of the Akar River but had to return on November 19. According to his own account "failure was due in the first place to the lack of food in the district, which prevented us obtaining sufficient natives for transport, and secondly to the alarming reports of a Dayak invasion which soon after our start robbed us of the few natives we had managed to get together."[10]

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[9] J. C. Moulton: An Expedition to Mount Batu Lawi, *Journ. Straits Branch Royal Asiatic Soc.*, No. 63, Singapore, 1912, pp. 1–104.

[10] J. C. Moulton: Thirteenth Report on the Sarawak Museum, 1914, Sarawak, [1915,] p. 3.

Another attempt to reach the mountain was made by Moulton in 1920. In that expedition Mr. H. B. Crocker, Mr. Harrison Smith, and another European also took part, the first-named associate for the purpose of surveying the Baram River and its upper sources. The expedition, however, did not meet with success and soon returned.[11]

Up to 1922, therefore, Mt. Murud and the Kalabit country were unknown from a scientific point of view: Mt. Murud itself had been seen only at a distance by some few Europeans and had never been approached.

The Expedition:[12] First Stages

My plan of exploration was laid down before H. H. the Rajah on July 13, 1922, and immediately gained his approval. The necessary preparations having been made, I left for Baram Station (Claudetown) on September 6 in company with the District Officer, Mr. H. L. Owen. We proceeded up river in two big prau pulled by cheerful crews of Kayans and Kenyas. Without incident we reached the little fort at Lio Matu, the outpost on the upper course of the mighty Baram River, on September 19.

Rumors had already reached us about difficulties of getting sufficient carriers on account of a serious disease that was spreading rapidly and taking a great toll of human life among the Kalabits. We were now a two days' journey from the first Kalabit village. Leaving the main stream, we followed the small tributary Selungan until it became too shallow and then marched through hilly, heavily wooded country up and down hill, crossing the river not less than twenty-eight times. On several occasions we came across peculiar gates consisting of a rattan vine stretched across the little jungle path covered with freshly pulled caladium plants hung upside down. The carriers told us that the gates were a warning signal to strangers not to enter the disease-stricken country. As we approached the first Kalabit village, the serious nature of the epidemic, apparently a bad form of influenza, was confirmed. There was no hope of getting the assistance we expected from the native chief, Tama Liput. His people were too busy burying their dead.

Mr. Owen had received orders from the Resident, Mr. Douglas, to make certain arrangements with Penghulu Tama Ujan, of Akar River, to send about 70 carriers to meet me at Tama Liput's house. As no sign of them could be seen, two of my policemen were dispatched to his house to remind him of his duty. He, however, flatly refused to send a single man.

Mr. Owen now had to return. I myself pushed ahead with my small party of 12 Dyaks. I erected a small temporary camp close to the Tutau River, a tributary of the Baram rising on the western slopes of the Pamabo Range, and occupied myself with study of the extraordinary rich animal life of the surrounding jungle. The weather kept beautiful the whole

[11] Report of Raffles Museum for 1920.

[12] A detailed report of the Expedition, to appear in the *Sarawak Museum Journal*, is now in press.

time, with only occasional refreshing showers. The altitude of my camp was 1040 feet.[13]

I ordered my policeman, Assan, to push ahead northward as fast as possible, to seek carriers from the houses en route, and to enter the Kalabit country proper on the other side of the Pamabo Range. In this he was highly successful. On October 4 12 carriers appeared and soon afterwards 43 more.

On the 5th I broke camp, marching along all day across rough ground made very slippery by the incessant torrents of rain. We crossed and followed for some time a small stream, Sungei Labit, an "anak Tutau" (child of Tutau), i. e. one of its tributaries. On several occasions the Pamabo Range was visible as a majestic blue range in the distance. At midday we entered an oak zone.

Eventually we reached a good-sized hill, where we were glad to pitch camp. The leeches, encouraged by the copious rainfall, had been very persistent and the feet and legs of my carriers were bleeding freely. The next morning an early start was made to reach the village of Panglah (altitude 1250 feet) where I had promised the carriers a day's complete rest. Going was again heavy, and we welcomed the sight of a valley clearing covered with long grass, indicating the vicinity of the village. Hungry and wet through, we reached a long house of the usual type with an open veranda at the end and a notched log leading up to it.

The Kalabit house has been already described by Douglas. It is of the general native type, covered with *atap* and entirely waterproof and, one may add, mosquito-proof too, on account of the smoke from the permanent fires. Under the house the pigs and fowls live in filth. Near the house are small clearings where catella (*Manihot utilissima*), taro (*Caladium, Calocasia*), papayas (*Carica*), bananas, tobacco, etc. are grown in sufficient quantities to meet the local needs.

The Kalabit people seem to be badly off in respect of domestic implements, weapons, garments, and decorative art. Their dress is the simplest possible consisting chiefly in a loin cloth of bark and a bark coat, often fringed with a modern border in the shape of a narrow stripe of Turkey red. Sometimes a cap of bark or of squirrel skin is worn.

I broke camp on October 8 and continued the march in a northerly direction. After some hours we struck the Kebaan stream, a tributary of the Tutau River, just where Panglah River joins it. From here we marched in a north-northeasterly direction, ascending slowly a big jungle-clad hill, according to my people an "anak Pamabo." On Douglas' map, which I found quite correct in the main features as far as the western Kalabit country is concerned, this hill is marked as a small isolated range running nearly at right angles to the Pamabo Range and probably constituting one of its spurs. After heavy marching through thick jungle we came to an old clearing and shortly reached the village of Penghulu Tapo Boan.

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[13] On my journeys I always adhered to the plan of carrying two aneroids. This particular time I had one graded in feet, the other in meters.

FIG. 2

FIG. 3

FIG. 2—The government boat in rapids on the Baram River.
FIG. 3—Kenyah carriers on the Baram River.

The village itself was the largest I have seen in the Kalabit country. The two long houses, built close together, must have been at least 200 feet long and were surrounded by well-kept gardens of bananas, catellas, taro, pumpkins, etc. In front of the house was a big grass-covered clearing, where a herd of a dozen buffaloes were seen grazing. In the middle of the lawn a neat little *atap*-covered house had been erected for the exclusive use of distinguished visitors. The distance from Tapo Boan's village to the Pamabo Range cannot be more than five miles. The altitude proved to be 1950 feet above sea level. The temperature in the nights went down to about 63° F.

We resumed our journey on the 10th and after an hour's march came to a *sawah* where rice is grown by irrigation. The Kalabits are a very industrious people. All the tribes on the other side of the Pamabo Range are self-supporting owing to the fact that they harvest two crops a year from their rice fields. As we shall see later on, they have also salt manufactures and a considerable trade in that commodity.

The route now lay in an easterly direction. We crossed the Kabaan River, here filled with enormous fantastically shaped boulders and overhung with luxuriant vegetation. I could plainly see the big Pamabo Range. My attention was especially attracted to a high peak with whitish cliffs shimmering and glittering in the bright sunlight. The natives called it Ikap Tenidan. Our altitude was then 2100 feet.

About midday we began to climb the steep jungle-clad range. From the summit (3950 feet) we could at first see nothing beyond our immediate surroundings. Walking farther along, however, we suddenly came to an open place and saw below us stretching eastward to the horizon the whole Kalabit country lying unrolled like a map. We all sat down to admire the wonderful panorama, a vast plain covered with grass and rice fields. At our feet we could plainly see the house of Dalam Bah; farther to the southeast dense smoke rose towards the skies, indicating the position of Mein village; and farther to the east lay two dark wooded hills marking the site of Pamour village. The whole landscape was bathed in friendly sunlight, a relief after the dark rain-dripping jungle. Towards the east I could see far into Dutch territory, which here is separated from Sarawak by a continuous high range, Apo Duat, running north and south and sending spurs westward into the Kalabit country. Hundreds and hundreds of peaks and many mountain chains could be seen. Following a narrow track through old rice fields, we finally saw the smoke of the Dalam Bah houses quite close and soon reached the small village (2950 feet). The climate was beautifully cool, and the air rarefied, dry, and exhilarating.

On leaving the Dalam Bah clearings we entered light jungle, and the headman who accompanied us told me that the whole of the big Kalabit plain in the earlier days had been jungle-clad, but within the memory of his people it had been cleared bit by bit to get fertile soil for their rice fields. Part of our way led through an open plain with very swampy moss-covered

ground. The moss was a real white moss (*Sphagnum* sp.), and the whole landscape reminded me very much of Europe, although a glance at the other botanical growth soon enough dispelled the illusion. Among other forms the pitchers of *Nepenthes* were especially abundant.

Mt. Murud Sighted

All of a sudden we struck an old friend, the Baram River, which at this point runs from east to west under another name, Pah Dapur. It was here

Fig. 4—The long house of Panglah village, Kalabit country.

about ten feet wide with comparatively clear water. Later we crossed the Pah Dapur again, now running in more southerly direction, and left the jungle behind to enter a sunny, open grass country. About midday we climbed a small hill, and no sooner had we come to the top of it than two of my carriers burst out: "Sana Toewan, Bukit Murud!"

And sure enough, due northwest, I could plainly see a lofty mountain towering to an imposing height, Mt. Murud, my long-wished-for goal. Heavy white clouds were floating slowly over and round its summit, partly hiding it from inquisitive gaze.

Two hours' marching through open country brought us to the village of Pah Trap (2850 feet) at the foot of a hill. All the surrounding hills had been cleared of primeval jungle and were now more or less overgrown by secondary forest. The population of Pah Trap, including another smaller house some distance from the bigger one, numbered about 150 souls.

All the Kalabits are extremely eager to procure gunpowder, and fortunately I had brought a fair quantity of this article along. A lot of old-fashioned guns have found their way into their country from the Dutch side, and the Kalabits were eager to make use of them. So far as I could gather, there is a small Chinese bazaar about four days' journey into the Dutch territory, which the salt-producing Mein people visit, bringing other trading articles back in exchange. It has been said that the Kalabits are able to make their own gunpowder, but I can safely state that such is not the case.

When in Pah Trap I met a strange wanderer, a solitary Pah Brian man who apparently was out on some secret burial mission, for he had on his back well tied up in his *salabit* a big burial jar. The man could not speak Malay, and the Kalabits did not seem inclined to give away his secret, though they probably knew on what mission he was engaged.

FIG. 5—Girls of the Kalabit country.

On October 15 I called the chief Paramatto and some of the subchiefs who had arrived from other villages farther south to a meeting and informed them that I wanted to break camp early next morning and that I expected them to follow me.

All sorts of excuses were brought forward. Some declared that they did not dare to go to Mt. Murud for fear of evil spirits. Others dreaded the wandering head-hunting parties of the Pabawan and Brunei people living west of the mountain who from time to time were said to roam the ranges between Pah Trap and the foot of Mt. Murud. According to Paramatto one head was obtained there in 1920. The Pah Trap people had never been even so far as to the foot of Mt. Murud. By bribery and cajolery, however, they were eventually persuaded to accompany me.

As no roads or paths existed, a small party consisting of Paramatto himself, two subchiefs, and five selected men, all well armed, were dispatched at 2 P. M. the same day to cut a track through the dense jungle. The next morning I set off with my long string of carriers. Five minutes' walk, and a little innocent bird happened to call from his branch. The whole caravan stopped. A friendly *anto* had talked through the bird and advised the people to sit down and wait a little, if they wanted to have luck on the long journey. And there was nothing to do but obey. Fortunately no further call was heard, and, danger averted, we followed up the faint track made by our advance party over the heavily wooded Bukit Kaban, a high chain plainly visible from Pah Trap. After some two hours' walk at good speed

we struck an "anak Baram," called Salap Palongan, running from west to east. It was a fine wide stream fringed by beautiful patches of very old and thick bamboo canes. About 2 P. M. we struck the stream again, here running from north to south, and followed its course for the rest of the day's march.

The next morning we started out over low, flat ground for about half an hour, when we began to climb slowly. We ascended a steep spur, following the stony course of a small creek, and another precipitous hill to the high ridge Nata Ragong, which with smaller local deviations runs from north to south and, as it turned out, led us right to the foot of Mt. Murud. The ridge was narrow, sharp, and treacherous: a network of roots covered with a thin layer of humus concealed deep holes, and on either side the ground fell away in sheer precipices of several hundred feet.

FIG. 6—Pah Brian man carrying burial jar.

At 10 A. M. we were at 4000 feet proceeding in a more northeasterly direction. Very far away to the northeast I noticed a high peak in the direction of the Pabawan people's country, actually the Gura Peak in Dutch territory. It surprised me to find such heavy jungle at an altitude of 4000 feet. Some of the trees were real giants with a diameter of more than four feet. Judging from the appearance of the bark they must have belonged to several species. After descending slowly and rising again the early afternoon found us at 4300 feet. I was surprised to discover at this altitude a big black nest of a termite (*Mirotermes* sp.). From now on the character of the landscape changed. The undergrowth grew denser and, interwoven with rattan, made progress exceedingly slow. Dusk overtook us and forced us to camp at the top of a ridge. A cold, cutting wind blew throughout the night bringing down the mercury to 58° F.

The next morning by 10 o'clock we had reached the highest peak of Nata Ragong, nameless according to Paramatto, in spite of its 4750 feet and its domination of the whole range. The peak itself was bare of trees, the ground being overgrown with grass and tall ferns. Some orchids were found. The sun was burning fiercely, and even the natives, who had shivered from cold some hours before, moved into the shade. Naked sandstone rock was seen in several places.

The Foot of Mt. Murud Reached

I saw here for the first time the Batu Litan Range, running west-northwest and terminating the Pamabo Range northwards. The higher parts of

Mt. Murud were plainly seen sloping down to the north to a deep valley between this peak and Batu Litan. A little farther east the Baram River could be seen as a silvery streak running through the dark jungle-clad valley. I had the great satisfaction of pitching my camp (3450 feet) that night at the very foot of Mt. Murud. It was October 19.

My Kalabits were now far from cheery. They were all suffering from sore feet and the exceptionally numerous leech bites. Fear of the evil spirits of the awesome mountain and the strange feeling of being in an unknown country, which later I also shared, helped to discourage them. Fortunately the following morning was beautifully clear. We passed over rough ground strewn with enormous sandstone boulders. On every hand were dark mysterious-looking caves and deep crevices. My carriers had difficulty in getting through with their heavy loads.

At an altitude of 5000 feet advance became still more difficult though the jungle was thinner here. Tree trunks, stones, and ground were covered with a thick coating of dripping wet moss. Roaring currents of subterranean water were heard beneath the network of roots on which we trod and which threatened to give away under our weight at any moment. The larger gaps had to be spanned by small tree trunks lashed together with rattan. The carriers were forced to form a chain by firmly holding one another's hands. At 5200 feet I gave orders to pitch camp. After a rest and a smoke my followers were all put to work again cutting poles and collecting bark for the house, which was done very willingly. The chiefs and their people were then paid off and returned immediately as fast as their legs could carry them.

The Lower Camp on Mt. Murud

On October 20 amid loud cheers I hoisted the Sarawak flag on the new territory, never before trodden by human foot. And thus I was finally settled on Mt. Murud. The surroundings were strange enough. On one of the doorposts of my house a *Nepenthes* was growing, exposing a fine pitcher which helped me daily in catching insects. The trunks of the big jungle trees were covered with heavy coating of dark green moss and masses of epiphytic orchids and ferns. Here and there a liana exposed a bunch of blood-red flowers. Large pink snails were seen crawling over the wet ground, and on the first day a wonderful trilobite larva, one of these mysterious beetle larvae of unknown origin, a black species over three inches long with sealing-wax-red tubercules, was caught.

The nights were cold, the minimum being 53° F.; and heavy dew fell, making everything dripping wet in the mornings. In this camp I stayed until November 2 studying the immediate surroundings, except on the one day when I made a dash with a small selected party for the summit to prepare a suitable path for future use.

I had not been working many days in the new field of exploration before

I realized the great affinity between the famous fauna of Kinabalu and that of Mt. Murud situated more than a hundred miles farther south. Among the more conspicuous forms of life, the birds afforded clear evidence. Altogether I found nine birds more than one hundred miles farther south of their previously known home. To this we may add quite a number previously recorded only from Kinabalu and Mt. Dulit, and I feel confident that many more of what hitherto were considered exclusively Kinabalu

Fig. 7

Fig. 8

Figs. 7 and 8—Pandanus forests of western Sarawak at an altitude of 4000 feet.

birds would have been found not only on Mt. Murud but also in the intervening regions between Kinabalu and Mt. Murud and Mt. Dulit and even much farther south, proving that we have a continuous avifauna right through the central mountains of Borneo from Kinabalu in the north to Mt. Poi in the west and possibly with many forms south to the Müller and Schwaner Mountains. I have the more reason for this belief as during my recent expedition to Mt. Poi (November–December, 1923) I found there three of the Kinabalu birds—the flycatchers *Cryptolopha montis* and *Cr. trivirgata kinabaluensis* and the white-eye *Chlorocharis emiliae*, the latter two quite common on the top above 5000 feet.

Ascent to the Summit

On November 2 I decided to climb the top ridge. It was perhaps my most strenuous day during the whole journey. The last two hundred feet

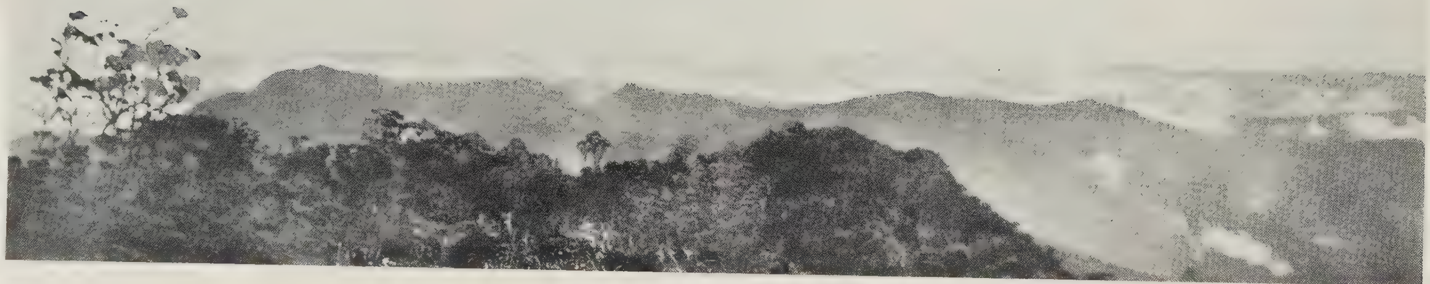

Fig. 9

Fig. 10

Fig. 9—Batu Litan seen from Mt. Murud. Batu Litan terminates the Pamabo Range northwards.
Fig. 10—Panorama of the west-southwest part of Mt. Murud with the two highest peaks.

proved especially trying, involving the scaling of sheer precipices; and here the rattan was our best friend. Ladder after ladder was made; great holes were spanned by poles over which we formed chains firmly holding one another's hands. The trees were heavily coated with thick moss from which water dripped constantly. Blood-red mushrooms and brightly colored orchid flowers were the only things breaking the monotony of this gloomy kingdom, where reigned the stillness of death. Just below the summit ridge naked sandstone rocks were seen as a sheer cliff of some thirty feet.

At last we reached the top of the ridge. The aneroid registered a height of 7040 feet. We found ourselves in a strange landscape where low bushes with thick leathery leaves constituted the predominating vegetation. Here and there smaller trees were seen, among them a conifer with trunk and larger branches practically covered with the yellow blossoms of a small, richly flowering, epiphytic orchid. Bright scarlet or snow-white flowers of rhododendron and similar plants were met with everywhere; and most noticeable were the enormous and characteristically shaped pitchers of *Nepenthes lowii*, hitherto recorded only from Kinabalu and Batu Lawi (1912). Only a single little yellow-breasted bird, *Chlorocharis emiliae*, broke the silence.

The higher bushes, or smaller trees, had all a very uniform appearance. The stems were bent and twisted, sometimes forming regular knots; and the leaves were concentrated on the top in the shape of a thin crown, the whole plant having a weather-beaten appearance which I had no difficulty in understanding after having stayed there a couple of hours exposed to a furious wind. Heavy fogs fast driving over the landscape entirely covered the lower ground.

On November 6 I decided to move my camp up to an altitude of 6000 feet to a spot already selected. It was a small plateau grassed in patches and fairly open. A violent storm was the evident cause of its condition. Big trees had been split up and thrown in wild confusion down the sides. The smaller growth had immediately taken advantage of the state of things and was now flourishing in the sunlight.

The daily range of temperature at this camp was only 10° F., the minimum being 54°, the maximum (in the shade) 64° F. with strikingly small variations.

I started on November 8 for the top of the mountain, bringing along only the most necessary things, having the day before dispatched a party with the needed baggage. The summit region of Mt. Murud is a broad area, crater-like in shape, with sharp edges and a shallow central valley sloping down in a northerly direction towards the valley at the foot of Batu Litan. Towards the west-southwestern corner the rim is highest, two peaks running up to 7160 and 7200 feet respectively. The entire summit, however, is covered by impenetrable shrubs making identification of the rock formation impossible. Traversing such ground is quite perilous, as hidden holes are found everywhere in which one may suddenly

sink to the armpits. I tried to fix the poles for my tent on a small hill to which our track from below had led us. We had managed to get hold of a fine straight pole, a difficult task among all the twisted and knotted trunks, and two of my Dyaks endeavored with united force to fix it in the ground when it suddenly went clean through and was seen no more.

At this highest camp the mercury dropped at 6 P. M. to 52° F. I found my Dyaks more dead than alive next morning and could not get a word out of them. As it was evident that they could not endure any more nights on the top, I promised to allow them to sleep at the lower camp in future; but they were to return to the top in the early morning to help me with the collecting work. Six days were spent on the summit. We made the most of one fine day. We all started early in the morning slowly working our way to the two peaks. With great difficulty and getting badly scratched we climbed both in succession. Even on the highest peak (7200 feet) fresh tracks of wild pigs (*Sus barbatus*) were seen. I had hoped very much to get a clear view of the southern and of the western portion of Mt. Murud's surroundings, but hardly had we started to climb the big peak before dense clouds hid all from view. On the night of the 11th I experienced a minimum temperature of 42° F., or only 10° above freezing point, and I really expected a snowstorm.

The morning of the 13th, my last day on the top, was, however, quite clear; and I was glad to secure some photographs. The unmistakable peak of Batu Lawi was seen due southwest but soon disappeared in clouds. The whole northern portion of the Pamabo Range was plainly visible, as were also the Kalabit country and the Northern Bah country (Pabawan people). I had tried in vain to catch a glimpse of Kinabalu, which ought to be visible from here on a clear day, but the atmosphere proved to be too dense.

The Return

Late in the evening of the 27th I reached safely Pah Trap's long house with my men and baggage. The next day, accompanied by Paramatto as a sort of honorary guest, I made for the Mein village farther south. We passed a long house at Pamour and in the afternoon reached the big long house of Mein, situated in the open grass-covered country where all the surrounding hills had been cleared for rice growing.

I was naturally eager to see the salt manufactories of which I had heard so much and which have been well described by Douglas. The salt mines are common property, but by long established custom the chief of the Mein village receives royalty on the output in money or gifts.

On December 2 we reached the most southerly village of the Kalabit country after four hours' marching. It is situated on the Lemuduk River at an altitude of 2600 feet and was at the time of my arrival split up into four or five smaller houses where the people seemed to live in a very crowded state. On the 4th I said good-by to the Kalabits and their country and

the inhabitants of Tamabo Tingan's village. This quite characteristic people, who according to Haddon are Indonesians of the Kalamantan group, number about 800–900 souls, men, women, and children. I do not think that the influenza took a smaller toll than 70–80 individuals. Thus the tribe has been reduced in number considerably, but as I could see no signs of apparent degeneration I think and hope that this friendly people, living their own life on secluded plains between high ranges far away from civilization, will long survive.

On the 8th I reached Lio Matu and stayed there until the 13th, when the river, which had been greatly swollen by the heavy rains, seemed to fall slightly and we ventured a start. Within four days I reached Baram Station, thus bringing my Kalabit and Mt. Murud expedition to a successful end without, I am glad to say, loss of life or property. A distance of roughly 400 miles on water and 200 miles on land, chiefly through jungle, had been covered during the expedition.

A NEW ESKIMO CULTURE IN HUDSON BAY

By Diamond Jenness
Victoria Memorial Museum, Ottawa

The discoveries of the Fifth Thule Expedition[1]—to name by its true title the Danish expedition under Knud Rasmussen which spent the years 1921 to 1923 in the northern portion of Hudson Bay—have thrown a flood of light on the complex ethnology of that region and on the diffusion of Eskimo culture from Alaska to Greenland. Dr. Birket-Smith, the ethnographer of the expedition, distinguishes three separate cultures in the Hudson Bay region. There is the culture of the inland, or Caribou, Eskimos, bound to lakes and rivers; the ancient culture of the coast, associated with houses of stone and whalebones and a population of whale hunters; and the culture of the coast Eskimos of the present day. He believes that the first culture, that of the Caribou Eskimos living around the Kazan, Dubawnt, and Thelon Rivers, represents a survival, slightly modified, of the culture of those proto-Eskimos who later descended to the coast and became the Eskimos of history; that the second culture developed in Bering Strait and spread east to Labrador and Greenland; and that the third, or modern culture of Hudson Bay, represents a new drive of inland tribes out to the coast within comparatively recent times.

Birket-Smith's explanation of the modern culture of Hudson Bay is peculiarly gratifying to the present writer, because it confirms his own hypothesis, published in a former number of the *Geographical Review*,[2] of "a general movement from inland about seven or eight centuries ago, both to the northern coast line and to the western shores of Hudson Bay." Therkel Mathiassen, the archeologist of the Danish expedition, separates it clearly from the second culture. He excavated some remains of the second culture at Ponds Inlet in the north of Baffin Island, on the neighboring Bylot Island, and, within Hudson Bay itself, at Repulse Bay, Vansittart Island, Chesterfield Inlet, and the northern end of Southampton Island. At all these places, now inhabited by seminomadic Eskimos who spend the winter in snow huts, he found circular houses, half subterranean, with walls built of stone, sods, and whale heads, and roofs made of the jawbones and ribs of whales covered over with sod. Many centuries had elapsed since they were last occupied. Some were so disintegrated that he could scarcely recognize them; others, and those the best preserved, the Eskimos themselves had rifled the year before his visit. His excavations,

[1] Foreløbig Beretning om Femte Thule-Ekspedition fra Grønland til Stillehavet *Geografisk Tidskrift*, Vol. 27, 1924, pp. 191–208. See the notes on the expedition in the *Geogr. Rev.*, Vol. 13, 1923, pp. 625–627, and Vol. 15, 1925, pp. 310–311.

[2] Diamond Jenness: Origin of the Copper Eskimos and Their Copper Culture, *Geogr. Rev.*, Vol. 13, 1923, pp. 540–551; reference on pp. 550–551.

nevertheless, yielded a very rich harvest, ample to prove that the culture of these early whale hunters not only differed very greatly from that of the present inhabitants of the region but resembled in its main outlines an ancient culture that extended from northern Alaska to Greenland. He has called it the Thule culture, because it was first discovered by the Second Thule Expedition near the station of Thule, in the Cape York district of northern Greenland.

FIG. 1—Sketch map showing the situation of Coats Island and Cape Dorset.

Thule and Modern Cultures

Mathiassen has illustrated some and listed other differences between this Thule culture in Hudson Bay and the modern one that has supplanted it. Peculiar to the Thule culture are clay vessels, the bolas, the bird harpoon, and the extensive use of baleen; to the modern, the ladle of musk-ox horn, drip stands and stone wick trimmers for lamps, combs for teasing out fur, etc. Many objects appear in both cultures under different forms. The Thule culture has harpoon heads with open sockets, arrowheads with long tangs for attachment to the shafts, women's knives lashed directly to the handles, oval pots, and snow knives, mattocks, and picks made of massive whalebones. The harpoon heads of the modern culture have closed sockets, the bases of the arrowheads are cut obliquely, women's knives are attached to their handles through an intermediate stem and the soapstone pots are rectangular.

Judging from the position of the ruins in relation to the present coast line Mathiassen came to the conclusion that the Thule culture dominated this region when the land was about ten meters below its present level. It prevailed until long after this date, especially in the north of Baffin Island. A newer culture that came from inland when the coast was from five to six meters lower gradually replaced it on the west coast of Hudson Bay; but it survived on Southampton Island, in a modified form, until the nineteenth century. Some of the Thule people went to Greenland; others wandered away to the south of Baffin Island and Labrador, where their culture has since been overlaid with another veneer.

Evidence of a New Culture

These discoveries explain the origin of hundreds of strange specimens that have found their way into various museums from the shores of Hudson Bay. Yet the complex ethnology of the region is still not completely unraveled. There are specimens that belong apparently to none of the cultures that the Danish scientists have distinguished but to another culture as yet undetermined. The National Museum at Ottawa acquired some years ago four harpoon heads which conformed to no type of which there is any record. Two came from Coats Island, one from Southampton Island, and

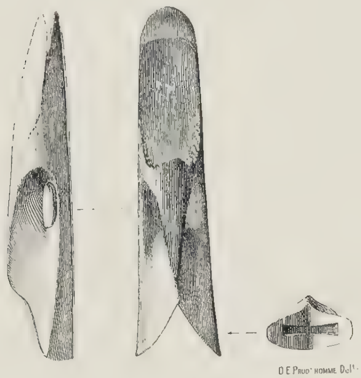

Fig. 2

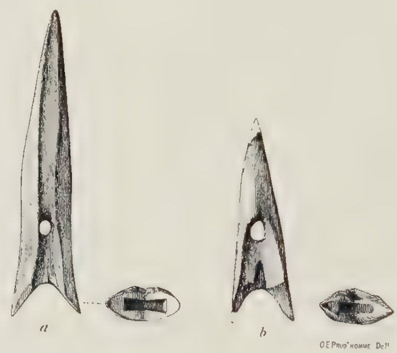

Fig. 3

Fig. 2—Bone harpoon head from Coats Island, with narrow, rectilinear socket. Half natural size.

Fig. 3—Bone harpoon heads with narrow, rectilinear sockets; *a*, from Coats Island; *b*, from Southampton Island. Half natural size.

the fourth from some Eskimos of Chesterfield Inlet—all within Hudson Bay. The sockets of these harpoon heads were narrow, rectilinear slots, not rounded holes or half-cylindrical grooves; and the line holes were made not by drilling but by gouging with a knife or similar tool. The sockets are shown in detail in Figures 1 and 2, which illustrate three of the specimens.

Isolated, these harpoon heads remained a mystery. An explanation suggested itself last winter. The same types then appeared again in two collections obtained by Major L. T. Burwash, exploratory engineer of the North-West Territories Branch of the Department of the Interior, and presented by his Department to the Museum. Major Burwash purchased one collection from a factor of the Hudson's Bay Company and knew no more than that it came from Coats Island. His own Eskimos dug up the second collection at Cape Dorset, in the southeastern corner of Baffin Island, and he was able to furnish me with the following information.

Cape Dorset Collection

These specimens were secured from circular stone houses located 12 miles northwest of the Hudson's Bay Company's Post at Cape Dorset.

Similar houses exist, two within a few feet of Dorset Post and a number across Dorset Harbor at a distance of slightly over half a mile. The elevation of the two houses at Dorset

is not more than twenty feet above sea level. These I excavated myself but obtained practically no specimens from them.

The houses from which the specimens were obtained were at an elevation of possibly thirty feet above sea level. All of these houses are intact, but the floors are buried from 8 inches to 30 inches under black vegetable mold or a sand-mold mixture. They are constructed of heavy boulders and large whalebones. The walls are not more than 30 inches high, which is much lower than those observed on Admiralty Inlet [at the north end of Baffin Island].

The sites do not appear to have been recently occupied, and there is no outstanding evidence, when excavating, of more than one stratum of débris, although on the sites of the old *Koodlees* [lamps] the deposit-carrying specimens might be 15 inches thick.

The whole coast line has many camp sites scattered along it, but the stone igloos appear to be entirely separate from the present civilization. No human bones were found in the stone igloos, but well-constructed graves were found in the vicinity. They did not appear to contain bones; but, as no serious work was done on them, this cannot be stated positively.

FIG. 4—Stone implements from Cape Dorset: *a*, single-edge knife of slate, broken; *b*, slate knife for lance or harpoon; *c*, adz blade of nephrite; *d*, flint knife; *e*, quartz knife; *f*, arrowhead of quartz; *g*, arrowhead of flint; *h*, flint scraper; *i*, curved-edge knife of flint; *j*, curved-edge knife of quartz; *k*, arrowhead of flint; *l*, lance head of quartz; *m*, *n*, women's knives of slate; *o*, quartz rubbing stone. *O*, half natural size; *a*, *b*, *k*, *m*, *n*, seven-twelfths; the rest, two-thirds.

The shapes of these houses, the materials used in their construction, and their height above sea level all suggest that they belong to Mathiassen's Thule period. For any further information we must turn to the specimens themselves. They numbered about 2000, without counting double that number of worthless fragments. Unfortunately the Eskimos who gathered them did not separate the objects from different sites or from different layers of the same site. They jumbled everything together into bags, not caring whether they mingled modern harpoon

heads of their own manufacture or the discarded weapons of a forgotten past. In endeavoring to separate and classify the objects, therefore, I had to rely mainly on their forms.

Stone Implements

The collection included something like 500 specimens of flint, quartz, slate, and soapstone—all of which occur plentifully in the neighborhood. Nearly 30 per cent were of quartz, an exceptionally high proportion, owing probably to the abundance of quartz in suitable form along the south shore of Baffin Island. Six implements of nephrite were unexpected, for that mineral, though plentiful in Alaska, is not known to occur east of the Rocky Mountains except on the Rae River in Coronation Gulf, where Sir John Richardson reported, on the authority of his companion, Rae, "thin beds of soapstone and some nephrite, or jade."[3] I have seen no nephrite implements from any district east of the Mackenzie River delta, except these six from Cape Dorset. Probably the mineral exists in a small deposit, little known and seldom utilized, somewhere in the south of Baffin Island.

Nearly all the types of stone implements in the Cape Dorset collection are shown in Figure 3, where *c* represents one of nephrite, probably an adz head. The majority of the specimens resemble those from other Eskimo regions, but there are three new types. *F* and *g* are arrow or lance points, one of quartz, the other of flint, which have concave bases like the arrow points of the Iroquois and other Indians to the southward; the arrow or lance points typical of Eskimo culture have tangs like the two specimens *k* and *l*. *I* and *j* (*i* a flint implement, *j* a quartz), are curved-edged knives that seem unknown from any other region. *O* represents still another new implement not easy to illustrate clearly. It is a block of quartz ground flat and smooth on three faces. Other examples are polished on one or two faces only; the grinding of one face alone must have required an immense amount of time and patience. The implements were doubtless polishing stones, but their exact purpose is uncertain.

None of the specimens illustrated in this figure are solitary examples but are representative of many others in the same collection. There were about 30 arrow or lance points with concave bases and 50 or more knives of flint and quartz showing one edge deliberately curved. The types were evidently well established in this area. Polishing stones of quartz were less common: there were only six. But they are less useful than arrow points or knives and are more difficult to manufacture.

We can learn nothing about the antiquity of these stone implements from their shapes or outward appearance. Stratigraphical evidence is lacking; some of them may be quite modern, others very ancient. We can only say that among many common types of specimens there are three new types which have not been reported from any other region.

[3]Sir John Richardson: Arctic Searching Expedition, 2 vols., London, 1851; reference in Vol. 1, p. 312.

Objects of Bone and Ivory

Objects of bone, antler, and ivory made up the greater portion of the Cape Dorset collection, numbering around 1500 specimens. Some were obviously modern, but the majority were greatly weathered and decayed. The first step naturally was to sort them out according to their types, a difficult process because so many of the specimens were fragments only; but my attention was instantly attracted to the great differences in patination. Modern specimens such as the Eskimos have used during the last two centuries could often be distinguished by their freshness; the bone or ivory

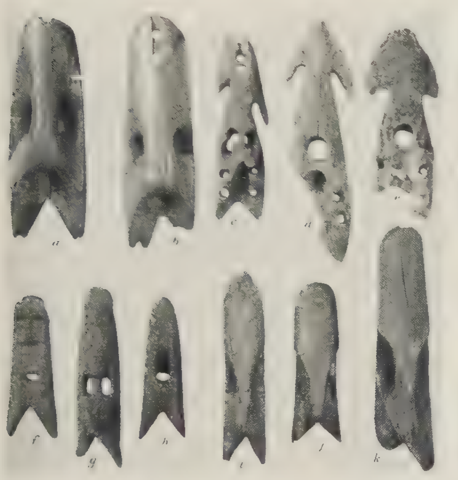

Fig. 5

Fig. 6

Fig. 5—Harpoon heads from Cape Dorset, of bone and ivory; *a*, *b*, modern forms with closed sockets; *c*, *d*, *e*, Thule forms with open sockets; *f–k*, new forms with narrow, rectilinear sockets.

Fig. 6—Bone, ivory, and antler objects from Cape Dorset, deeply patinated; *a*, *k*, *l*, uses unknown; *b–j*, darts of various kinds (*d*, though deeply patinated is hardly weathered and has a more modern appearance than the other darts: it may be an ancient implement remodeled in more recent times); *m*, *n*, perhaps foreshafts of harpoons; *o*, *p*, perhaps butts of harpoons; *q*, portion of snow knife. Three-eighths natural size.

was hardly discolored, whereas a brownish-yellow patina covered the surfaces of the implements of Thule culture. But patination alone was not a safe guide, for some implements of modern type had also undergone much weathering and discoloration.

I placed on one side all the specimens that, from our own museum collections and from the works of Boas, Mathiassen, and others, I recognized as belonging to either the Thule or the modern culture. In other trays were laid all the fragments and pieces of doubtful use which had the same color as the first lot and might reasonably be assigned to the same periods. There still remained some 500 specimens so much darker than all the rest that a child could pick them out with certainty. The others were yellowish-brown; these were a deep chocolate. Their appearance strongly indicated that they were the oldest objects in the collection.

Patination alone is often misleading. One end of a piece of ivory may discolor more than the other through contact with a different soil. But another peculiarity was instantly manifest; these dark objects were nearly all strange and unfamiliar. There were about 150 harpoon heads, most of them broken but every one different from the harpoon heads of the Thule and modern cultures. They had the same peculiar sockets as the mysterious specimens from Coats and Southampton Islands shown in Figures 1 and 2; and the line holes were made in the same way, by gouging with a knife or other tool, not by drilling.

Fig. 7—Bone and ivory objects from Cape Dorset, deeply patinated; *a, b, c,* knives for stone blades; *d,* half of a pair of snow goggles; *e, g, h, i,* probably ornaments; *f,* needle; *j,* use unknown. Half natural size.

Figure 4 illustrates the various harpoon heads in the Cape Dorset collection. In the upper row *a* and *b* are modern forms, *c, d,* and *e* represent the Thule culture; the darker specimens in the bottom row are the new and unfamiliar types. The reader will notice the human head carved on *f;* it is the only example known to me of carving on a harpoon head.

I tried to discover the foreshafts that were used with these strange harpoon heads. Only two specimens seemed in any way suitable; they are shown in Figure 5, *m* and *n*. Their fore ends are blunt and chisel-shaped, as they must be to fit the narrow, rectilinear sockets; the rear ends were clearly lashed to a shaft, and the holes were gouged for further lashings that would render them more secure. If these implements are not foreshafts it is difficult to guess their use; if they are foreshafts it is strange that only two should appear in a collection where the harpoon heads themselves numbered 150.

Figures 5 and 6 show other darkly patinated forms from Cape Dorset, nearly all of unusual types. Holes near the edges instead of in the middle are very characteristic. Small knives (Fig. 6, *a, b,* and *c*) were very common; two of them still retained in their sockets tiny fragments of quartz that may have been portions of the original blades. A few knives have sockets on both sides: they were two-bladed. Some darts too had sockets for stone

blades: in Figure 5 *h* and *j* are examples, although the sockets are barely visible in that illustration. More carving of no little merit appears in Figure 6, *h* and *j*.

Every specimen in these two illustrations has the dark-brown patination which seems to indicate great antiquity, a patination not found on any objects from the same site that I could ascribe definitely to Thule or modern culture. Many of these dark specimens, too, are new to Eskimo archeology: we can only guess at their uses. But the most remarkable feature about all the 500 is that not one of them shows the mark of a drill: every hole was made by gouging. The inference seems certain. Their makers, unlike all other Eskimos, were not acquainted with the bow drill; they belong to an old culture, hitherto unknown. I shall name it, temporarily, the Cape Dorset culture.

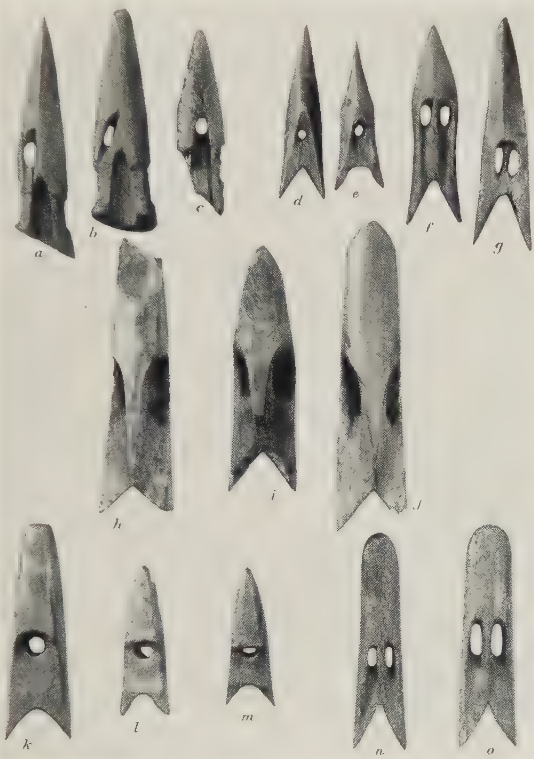

FIG. 8—Harpoon heads from Coats Island, of bone and ivory; all have narrow, rectilinear sockets except *a*, *b*, and *c*. Half natural size.

We see now the reason for the peculiar sockets in the harpoon heads; it was very difficult for these Eskimos to gouge out a circular hole. We can understand, also, why so many of the implements are pierced near the edges instead of in the middle and why, when old holes broke away, new holes were also made near the edges. Gouging is laborious, and the thinnest place was chosen.

No tribe that had once known the bow drill would have forgotten its use. The Eskimos often employ it today in preference to the brace and bit. Its absence in the Cape Dorset culture proves that it was not one of the earliest inventions of the Eskimos: the harpoon preceded it, probably also the kayak. If the Thule culture arose in Bering Strait and spread eastward, as Birket-Smith believes, the bow drill perhaps came with it.

The strange stone implements of Figure 3 remain unsolved, but we may tentatively connect them with the Cape Dorset culture because they have not been reported from outside its range.

Coats Island Collection

Let us turn now to the specimens from Coats Island. They numbered about 150, all made of bone or ivory; 50 or more were needles. Ten specimens belonged clearly to the Thule and modern cultures; the remainder corresponded just as clearly with the strange specimens from Cape Dorset, although the patination was very much lighter. All perforations were made by gouging. It is true that some broken needles had drilled eyes; but this drilling was modern, for the holes were white, not yellow like the rest of the bone, and the unbroken needles had gouged eyes. The 100 harpoon heads were of five different types, all represented in Figure 7. Three simply reproduce the three types found at Cape Dorset. The fourth (Fig. 7, *e*, *d*, *f*, *g*) differs only in a minor detail; it has the same rectilinear socket but no slot for a stone blade, terminating instead in a sharp point. The fifth type (Fig. 7, *a*, *b*, *c*) has an open socket like the harpoon heads of the Thule culture (Fig. 4, *c*, *d*, *e*); but there is no drilling, there are no holes for the lashing around the foreshaft, and in 40 of the 60 specimens the line hole lies characteristically near one edge. It seems reasonable to ascribe it to the same period as the other harpoon heads.

Fig. 9—Bone, antler, and ivory objects from Coats Island; *a*, *f*, uses unknown; *g*, *k*, darts for fish (?); *h*, *j*, needles. Nine-sixteenths natural size.

A few more specimens from Coats Island belonging to the same culture are illustrated in Figure 8, where the gouging of the holes is still more evident. We noticed some carving in the Cape Dorset collection; in Figure 8 *e* another example is shown. Artistic skill is an ancient heritage of the Eskimos, as old, perhaps, as the people themselves. Major Burwash could furnish no information concerning the sites where the Coats Island specimens were found.

Age and Range of the Cape Dorset Culture

The corresponding specimens from Cape Dorset came apparently from the ruined houses of stone and whalebones which elsewhere seem to have yielded objects of the Thule culture only. Here the Thule culture is the later, not the earlier, for its implements are better preserved and less deeply patinated. Mathiassen's Thule tribes, wandering to the south of Baffin Island, found another people in possession of the coast. We cannot assume, however, that the Thule sites are everywhere of later date; the ruins that Mathiassen excavated in Repulse Bay were more ancient than the rest and may predate any settlement of the Cape Dorset culture.

The range of the Cape Dorset culture is as uncertain as its age. It left extensive remains at Cape Dorset and on Coats Island. One harpoon head with the characteristic socket was found on Southampton Island; another, of doubtful origin, was purchased in Chesterfield Inlet. The culture probably extended throughout the western entrance to Hudson Strait; for the Eskimos, following presumably an ancient route, travel from Cape Dorset by way of Salisbury and Nottingham Islands to the north Labrador coast, thence by Mansel and Coats Islands to the south shore of Southampton Island. Heavy ice makes a direct crossing from Cape Dorset to Southampton Island exceedingly dangerous and often impossible. This may explain why Mathiassen seems to have found only Thule remains in York Bay, at the northern extremity of that island; although, since his report was merely preliminary and his collections are now being studied in detail, some elements of this strange new culture may still be discovered in that area.

The Cape Dorset culture, while more primitive in some respects than the Thule, is certainly not the culture of the first Eskimos who settled on the coast and gained their livelihood by hunting the sea mammals. Of that earliest culture we have yet to find the remains.

SEA LEVEL ALONG THE ATLANTIC COAST OF THE UNITED STATES AND ITS FLUCTUATIONS

By H. A. Marmer
U. S. Coast and Geodetic Survey

Sea level, or more precisely mean sea level, is a term of frequent use, especially in geographic and geologic literature. It is the universal datum from which the heights on land and the depths in the sea are reckoned. As generally used, the term is apparently free from any ambiguity; indeed, the implication is that the determination of mean sea level is a simple matter. It is only when it becomes necessary to determine the plane of mean sea level accurately, as, for example, in the study of the subsidence or emergence of a coast, that numerous difficulties appear.

Even the very definition of mean sea level involves difficulties. The level of the sea is at all times disturbed by wind and tide. Is mean sea level, therefore, to be defined as the surface which the sea would assume if undisturbed by weather and tide? That, obviously, is a perfectly legitimate definition, and it is the one the geodesist prefers. In his own words mean sea level "may be defined as the surface which would coincide with the surface of the oceans and their tide water branches if the tide producing forces should cease to act and there were no movements of the air and the barometric pressure were uniform."[1]

For his investigations on the figure of the earth and for spreading his precise level nets over the interior of the country, the geodesist finds his definition of mean sea level satisfactory. In a sense, however, geodetic mean sea level is a hypothetical surface; for, while the effects of the rise and fall of the tide on sea level balance out if the observations are continued over a considerable period of time, the effects of air movements and of the non-uniform distribution of barometric pressure do not balance out but leave a net effect or resultant in the one or the other direction. And the elimination of these resultant effects is a problem of considerable magnitude.[2]

Geographic Mean Sea Level

For geographic and geologic purposes we may define mean sea level in another way and escape some of the difficulties inherent in geodetic mean sea level. With regard to any particular place we may define mean sea level as the average level of the sea, or as the plane about which the tide

[1] William Bowie: Present Status of Geodesy and Some of the Problems of This Branch of Geophysics, *Proc. Natl. Acad. of Sci.*, Vol. 6, 1920, pp. 545–555; reference on p. 548.

[2] See John F. Hayford: Effects of Winds and Barometric Pressures on the Great Lakes, Washington, D. C., 1922.

A. T. Doodson: Meteorological Perturbations of Sea Level and Tides, *Monthly Notices Royal Astronom. Soc., Geophysical Suppl.*, April, 1924.

oscillates. In contradistinction to geodetic sea level this plane may be called local sea level or geographic sea level. The advantage of this latter plane is that it may be determined directly from observations. For all that need be done is to obtain readings of the height of the tide at frequent intervals on a fixed vertical staff graduated to feet and tenths, the average of all these readings over a considerable period of time being the geographic mean sea level. It is the geographic mean sea level with which this paper is concerned, and when the term mean sea level is used here geographic mean sea level is meant.

It is to be noted that in geographic mean sea level, as defined above, the effects of meteorological conditions are not eliminated, the resultant or net effects of variations in wind and barometric pressure being reflected in the level of the sea; but, since these variations are largely of a seasonal nature, their effects will be approximately constant from year to year. The determination of mean sea level, therefore, resolves itself into a problem in the field of tides, and it is to the record of the rise and fall of the tide that recourse must be had.

It has generally been assumed that along an open coast mean sea level determined from tidal observations, or geographic mean sea level, is practically the same as geodetic mean sea level. For points not far distant the difference obviously must be very small; but where distances begin to be reckoned in hundreds of miles the differences are no longer negligible. Thus, recent precise leveling by the U. S. Coast and Geodetic Survey between New York City and Portland, Me., has brought out the fact that the plane of geographic sea level at Portland is about half a foot higher than that at New York City. In other words, in the 300 miles separating these places the planes of geodetic and geographic mean sea level diverge about half a foot.

Daily Sea Level

For how long a period must the height of the tide be averaged to secure an accurate determination of mean sea level? This question can best be answered by a consideration of the results derived from observations of different periods. Since the moon plays the leading rôle in the production of the tides, the average period of the tide, or the length of the tidal day, is the same as that of the lunar day. This period varies somewhat from one day to another in accordance with the position of the moon relative to earth and sun, but on the average it is 24 hours and 50 minutes, or approximately one day. Therefore, if we measure the height of the tide at frequent intervals during the period of a day and average these heights, the rise and fall of the tide will be very largely eliminated, the result being a close approximation of sea level for the day. However, the average level of the sea as determined from a single day of tidal observations may be very seriously in error because of varying meteorological conditions. Figure 1 shows the height of sea level from day to day for the month of February, 1919, as

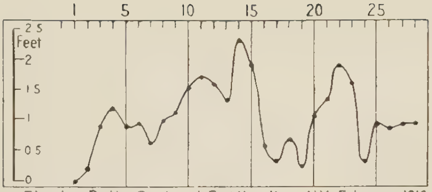

Fig. 1 – Daily Sea Level, Fort Hamilton, N.Y., February, 1919

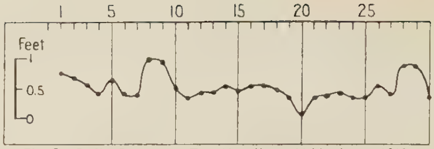

Fig. 2 – Daily Sea Level, Fort Hamilton, N.Y., June, 1919

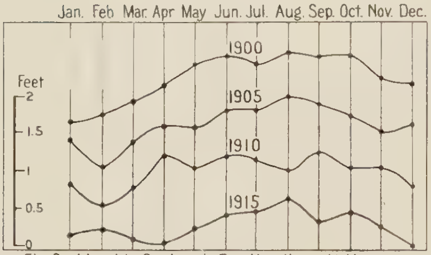

Fig. 3 – Monthly Sea Level, Fort Hamilton, N.Y.

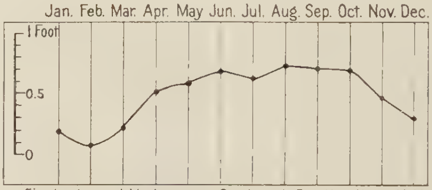

Fig. 4 – Annual Variation in Sea Level, Fort Hamilton, N.Y.

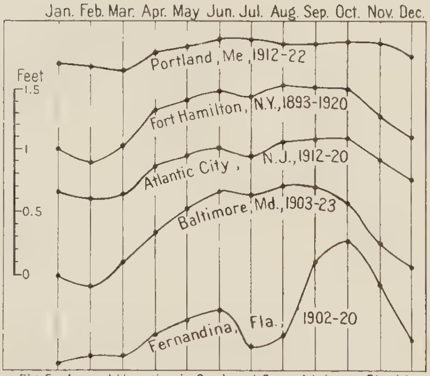

Fig. 5 – Annual Variation in Sea Level from Maine to Florida

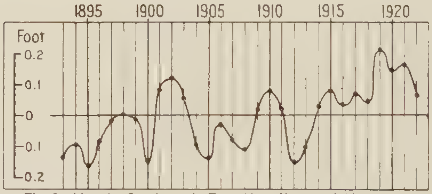

Fig. 6 – Yearly Sea Level, Fort Hamilton, N.Y.

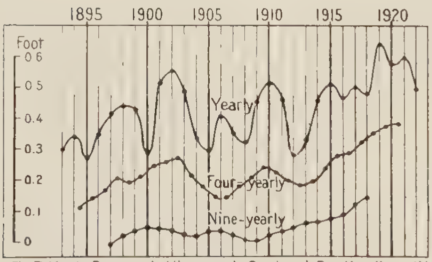

Fig. 7 – Yearly, Four-yearly, Nine-yearly Sea Level, Fort Hamilton, N.Y.

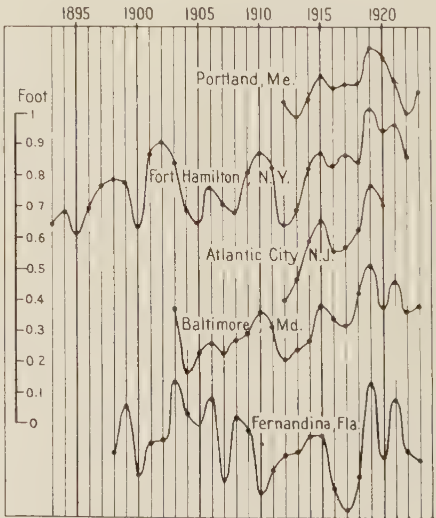

Fig. 8 – Yearly Sea Level, Atlantic coast

determined from an automatic tide-gauge record at Fort Hamilton at the entrance to New York harbor. For each day sea level was determined as the average of the 24 hourly heights of the tide, which practically eliminated the effects of rise and fall.

From day to day Figure 1 shows changes in sea level varying from less than one-tenth of a foot to more than a foot and a half. For this particular month—February, 1919—the difference between the greatest and least values of daily sea level was very nearly two and a half feet. February is generally a month of considerable variation in wind and weather, and the changes in sea level shown in Figure 1 may be ascribed, if not wholly at least in very large part, to these variations. For example, the diagram shows that from the 14th to the 17th of February sea level fell somewhat more than two feet. The weather record for these days shows decided changes: on the 13th and 14th the wind was easterly with velocities up to 35 miles an hour, but on the 15th the wind shifted to the northwest, increasing steadily and attaining on the 16th a velocity of 62 miles an hour.

During the winter months sea level determined from one day of observations may thus differ considerably from the level determined on another day because of the varying weather conditions. The question now arises, does sea level change from day to day during the summer, when the weather is much more stable? Figure 2 shows the change in daily sea level in New York harbor for the month of June, 1919, four months later than the period represented in Figure 1. The weather conditions during this month were relatively uniform, and the changes in sea level from day to day are seen to be much less than during February. As against a difference between the greatest and least values of daily sea level of two and a half feet in February, this difference in June is somewhat less than a foot. The important feature of Figure 2, however, is that, even with apparently uniform weather conditions, there is a change in sea level from day to day. That is, sea level changes from day to day altogether apart from the effects of apparent variations in wind and weather.

In part, the change in sea level from day to day is due to tidal constituents having periods greater than a day and arising from variations in the position of the moon relative to earth and sun. In passing it may be noted that, since the tidal day is 24 hours 50 minutes in length, a slight variation in sea level is introduced by taking daily sea level as the average of the twenty-four hourly heights of the tide for each calendar day; but this variation, it can be shown, is relatively insignificant.

Monthly Sea Level

In consequence of its change from day to day, sea level determined from one day of observations, even in calm weather, may be seriously in error, and a longer series of tidal observations is necessary for a more precise determination. How accurately can the mean level of the sea be determined

from one month of tidal observations? Figure 3 shows the monthly heights of sea level at Fort Hamilton, N. Y., for every fifth year for the period 1900 to 1915. The variation in sea level from month to month is seen to be less than that from day to day. Between any two consecutive months the greatest difference in sea level shown in Figure 3 is somewhat less than half a foot, while the difference between the least and greatest values for any one year is just under one foot. For accurate determination of mean sea level, therefore, the direct result from a month of observations leaves much to be desired.

Since the change in sea level from day to day is dependent very largely upon the variations in meteorological conditions, it is obvious that such changes are not periodic. In other words, from any one day to the next, sea level may be either higher or lower, depending upon the weather. A first glance at Figure 3 may lead one to conclude that the change in sea level from month to month likewise is not periodic; but a closer examination brings out the fact that sea level in New York harbor is lowest in the winter and highest in the late summer and early autumn. There appears, in other words, a seasonal change in sea level, or, more precisely, an annual variation in sea level.

Obviously the annual variation in sea level will differ somewhat from one year to another, inasmuch as the weather conditions do not repeat themselves from year to year. However, by averaging the monthly heights of sea level for a number of years, accidental or non-periodic variations will be eliminated, and the annual variation will appear in its periodic form. Figure 4 represents the monthly heights of sea level in New York harbor as derived from thirty years of continuous observations from 1893 to 1922, and it presents a curve of fairly regular outline.

In New York harbor, therefore, it appears that, apart from the effects of unusual weather conditions, sea level is lowest in the early part of February and highest in the latter part of August, the difference being somewhat more than half a foot. Figure 4 indicates also a secondary maximum and minimum in June and July respectively. This secondary maximum and minimum, it may be noted, is not an accidental irregularity in the curve of annual variation of sea level, for it is definitely indicated by the curve for each year.

It is to be expected that along an open coast the annual variation of sea level at any point would be representative of a considerable stretch of the coast line in its vicinity. Figure 4 may therefore be taken to represent the periodic change in sea level through the year for a considerable stretch of the Atlantic coast of the United States to the north and south of New York harbor. This is borne out by a comparison of the annual variation curves for Fort Hamilton and Atlantic City shown in Figure 5. Although Fort Hamilton is situated in the protected waters of Lower Bay in New York harbor, while Atlantic City is situated on the open coast of New Jersey nearly one hundred miles to the south, the two curves resemble each other closely.

For a determination of the annual variation of sea level along the Atlantic coast of the United States there are at hand the results of tidal observations made by the U. S. Coast and Geodetic Survey at a number of stations from Maine to Florida. In Figure 5 are shown the annual variation curves at five of these stations, the length of the series of observations on which each of the curves is based being indicated for each station.

To make the curves of Figure 5 strictly comparable they should be based on simultaneous series covering a considerable number of years. The periods of observation on which the curves of Figure 5 are based are of different lengths and are simultaneous only in part. There can, however, be no question that the period of observation is in each case of sufficient length to bring out the principal features of the annual variation of sea level on the Atlantic coast of the United States.

A glance at Figure 5 shows that the range of annual variation of sea level increases from north to south. At Portland this range is barely a quarter of a foot; at Fort Hamilton and Atlantic City it is a little over half a foot; at Baltimore it is more than three-quarters of a foot, while at Fernandina it is exactly one foot. But, notwithstanding the relatively great differences in the range of the annual variations shown in Figure 5, the phase of this variation does not differ much from Maine to Florida. In general, it may be said that along the Atlantic coast of the United States sea level is lowest in the winter months with the minimum in February; from this minimum, sea level rises gradually to a maximum in June, falls slightly to a secondary minimum in July, and then rises to the maximum of the year in September or October.

Yearly Sea Level

In view of its periodic annual variation, sea level along the Atlantic coast of the United States determined directly by one month of tidal observations may be in error by a quantity ranging from one-quarter of a foot to one foot. This error, further, may be augmented considerably by the non-periodic variation from month to month arising from variations in wind and weather. Where sea level is made the basis of studies of a quantitative nature we are therefore compelled to use a longer period of observations, and a year suggests itself as a desirable period, since the annual variation will balance out in the period of a year. We must therefore now turn to a consideration of the question whether there are any fluctuations in sea level from year to year.

Figure 6 gives in diagrammatic form the average yearly height of sea level at Fort Hamilton in New York harbor for the thirty year period from 1893 to 1922. The yearly height of sea level is derived as the average of the hourly heights of the tide throughout the year. In other words, each of the heights shown in Figure 6 is the average of more than eight thousand hourly heights of the level of the sea. The diagram shows at once that sea level does change from year to year, though it is to be noted that this change

is less than that from month to month. Generally the change in sea level from one year to the next is less than one-tenth of a foot, but it may be as great as one-quarter of a foot, which change is shown from 1900 to 1901.

The horizontal line of Figure 6, corresponding to the zero of the scale, represents the average sea level for the thirty year period from 1893 to 1922 and may be regarded as mean sea level in New York harbor. The fluctuation of sea level from year to year with regard to mean sea level for the thirty year period is clearly brought out by Figure 6. It is interesting to note that during the first sixteen years, from 1893 to 1908, sea level was the greater part of the time below the mean value, while during the last fourteen years it was above the mean value with but two exceptions. During the thirty years represented, sea level was lowest in 1895 and highest in 1919, the difference between the two being four-tenths of a foot. In passing it may be noted that Figure 6 indicates very clearly a periodic variation of sea level in New York harbor with a period of about four years. Thus the maxima of the curve occur successively in 1894, 1898, 1902, 1906, 1910, 1915 and 1919. We may eliminate this four year fluctuation by deriving sea level as the average of successive groups of four years, the resulting curve being shown by the middle curve of Figure 7.

With the elimination of the four year fluctuation there comes to light a fluctuation with a somewhat longer period. There are well established mathematical processes for determining the periods of periodic constituents, but here we need not concern ourselves with the matter.[3] It will be sufficient to call attention to the lower curve of Figure 8, which represents the curve of sea level that results by averaging the height of sea level in successive periods of nine years. The fluctuation in sea level from one period of nine years to another is seen to be small, but it is to be noted that in the period of twenty years from 1903 to 1924 sea level for the first nine year group differs from the last by a little more than one-tenth of a foot.

It will be recalled that all along the Atlantic coast of the United States the annual variation in sea level was very nearly in the same phase. The variation in sea level from year to year likewise is found to be very nearly similar over large areas, as is shown by a comparison of the curves in Figure 8, which gives the yearly heights of sea level at five stations from Maine to Florida.

Notwithstanding occasional differences in the fluctuation of sea level from year to year for the various stations, in general it appears that if for any year sea level is high at one point on the Atlantic coast of the United States it is high all along the coast, and similarly for a low sea level. Thus in 1913 sea level was in a low-level phase at Portland, and a glance at Figure 8 shows that sea level was also in a low-level phase at each of the other stations. For the period of observations at hand at Portland—1912 to 1923—the yearly sea level attained its highest value in 1919, and we find

[3] See G. A. Carse and G. Shearer: A Course in Fourier's Analysis and Periodogram Analysis, London, 1915.

that for this same twelve year period sea level at each of the other stations shown in Figure 8 likewise was at its highest elevation in 1919.

The Determination of Mean Sea Level

It appears, therefore, that the accurate determination of mean sea level at any point on the coast is far from being a simple matter, since sea level varies from day to day, from month to month, and from year to year. From the foregoing discussion it is evident that along the Atlantic coast of the United States a determination of mean sea level directly from tidal observations necessitates at least four years of observations, if any pretense at accuracy is to be made, and that nine years is much better.

However, in consequence of the fact that the fluctuation in sea level from year to year and even from month to month is much the same over large areas, the period of observations required for an accurate determination of mean sea level at any point may be shortened very materially if at some other point, not too far distant, a tidal station has been in operation for a number of years. An example may make this clear.

Suppose that in 1912 it was desired to determine accurately the plane of mean sea level on the coast of New Jersey, say at Atlantic City. This involved the establishment of an automatic tide gauge and also of bench marks which were connected with the zero of the tide gauge by careful spirit levels. The tide gauge having functioned the whole year, the hourly heights of the tide are averaged, and it is found that sea level was 10.20 feet below the primary bench mark. The question now to be determined is, what is the relation of *mean sea level* to this primary bench mark? Upon investigation it is found that the U. S. Coast and Geodetic Survey maintains to the north of Atlantic City a principal tidal station at Fort Hamilton in New York harbor and another principal tidal station to the south of Atlantic City, in Baltimore harbor. At that time the data for Fort Hamilton covered a period of twenty years and at Baltimore a period of ten years. A comparison of the data for Fort Hamilton discloses the fact that in 1912 sea level was ten-hundredths of a foot below the average sea level for the twenty year period from 1893 to 1912, while the Baltimore data show that in 1912 sea level was six-hundredths of a foot below the average level for the ten year period from 1903 to 1912.

From the previous discussion of sea level and its fluctuations it is reasonable to assume that sea level at Atlantic City will exhibit much the same fluctuations as at Fort Hamilton or at Baltimore. Since the Fort Hamilton data are based on a series twice the length of that at Baltimore, the result for Fort Hamilton is given twice the weight of that for Baltimore, from which it follows that in 1912 sea level at Atlantic City was nine-hundredths of a foot below a mean sea level based on a series of observations of about fifteen years in length. Mean sea level at Atlantic City would therefore be determined as 10.11 feet below the primary bench mark.

Had the observations been made in 1919, instead of 1912, it would have been found that sea level at Atlantic City for the year 1919 was 9.84 feet below the same primary bench mark. But by comparison with the results for Fort Hamilton and Baltimore a correction of twenty-three-hundredths of a foot is indicated, making the elevation of the primary bench mark above a mean sea level of about twenty years of 10.07 feet, which agrees with the corrected determination for the year 1912 within four-hundredths of a foot.

Sea Level and Coastal Subsidence

For studies of coastal subsidence, sea level determinations from tidal observations furnish perhaps the only data of a quantitative nature. It is with respect to such studies that the fluctuations of sea level have particular pertinency in determining whether a coast is subsiding, emerging, or stationary. If it be assumed, as is sometimes done, that sea level determined directly from one year of tidal observations gives a close approximation to mean sea level, erroneous conclusions with regard to the stability of the coast are bound to result.

As an example, suppose the alleged gradual subsidence of the coast of New Jersey were being studied and that the coast at Atlantic City were chosen, the study beginning in 1912. The elevations of substantial bench marks with respect to sea level were very carefully determined, sea level itself being based on continuous tidal observations for the entire year of 1912. It will be recalled that at Atlantic City sea level that year was 10.20 feet below the primary bench mark. Seven years later, in 1919, we may suppose the observations repeated with the same care as before. But now it is found that the primary bench mark was only 9.84 feet above sea level, indicating an apparent subsidence of the coast of 0.36 feet for the seven year period, or a subsidence at the rate of five feet a century.

Now it is to be noted that there can be no question as to the correctness of the mathematics of this result. But sea level determined directly from one year of observations is not mean sea level, and any deductions based on such a premise are bound to be wrong.

If, however, after finding an apparent subsidence of 0.36 foot between 1912 and 1919, the question of the fluctuation of sea level were looked into, it would be found that certain corrections to the sea level determined from one year of observations were necessary, as outlined in the previous section on the determination of mean sea level. On applying these corrections the apparent subsidence of more than a third of a foot would have been reduced to four-hundredths of a foot, or a quantity within the limits of error of the observations.

Formerly, the evidence presented in support of the view that the Atlantic coast of the United States was slowly sinking was considered convincing, and a subsidence at the rate of two feet a century was generally accepted as a well established fact. However, the data on which this conclusion

was based were largely of a qualitative nature, and recently it has been contended that these data permit of other interpretation. Evidence has been adduced in favor of coastal stability, and the belief that the Atlantic coast of the United States is sinking at the rate of two feet a century has been considerably shaken.[4]

What light do the tidal data throw on this matter? It must be admitted at once that the systematic tidal observations on the Atlantic coast have not been continued for a sufficient period to determine whether the coast is sinking or not. Taking Fort Hamilton, at which station the observations cover the longest period, it will be seen from the lower curve of Figure 7 that, if sea level is averaged for successive periods of nine years, the relation of sea level to land is very nearly constant from 1897 to 1909; but from the latter year there is a progressive rise of sea level to 1919, the rate averaging approximately 0.015 foot a year. For Baltimore, likewise, either a rise in sea level or a subsidence of the coast at a like rate is indicated for those years. But it is to be noted that from 1919 the yearly heights of sea level appear to be declining both for New York and Baltimore. It may therefore well be that the apparent subsidence of the coast from 1909 to 1919 represents but the rising phase of a fluctuation in sea level with a period of something like twenty years.

In connection with the question of coastal stability it must not be overlooked that there are involved two distinct problems in any change of relative elevation of land to sea. One of these relates to the change in the absolute height of the land while the other relates to the change in the absolute height of sea level. As regards local relative elevation of land to sea determined by means of tidal observations, it is to be noted that a stationary coast and a rising sea level will present the same set of data as a subsiding coast and a stationary sea level. In view of the enormous volume of the ocean waters and the fully demonstrated fact of local emergence and subsidence of the earth's crust, it is generally taken for granted that when a change in local relative elevation of land to sea takes place it is the land that has changed in absolute height.

The Causes of Fluctuation in Sea Level

The question of what brings about the fluctuations in sea level that we have been discussing opens up a subject with many ramifications. Undoubtedly these fluctuations are due to the variations in a large number of factors, among which may be mentioned barometric pressure, direction and velocity of the wind, precipitation and evaporation, temperature and density of sea water, and the velocity and direction of non-tidal currents. The large fluctuations in sea level that occur from day to day show a very close correlation with the variations in wind and in barometric pressure,[5] and

[4] D. W. Johnson: Is the Atlantic Coast Sinking? *Geogr. Rev.*, Vol. 3, 1917, pp. 135–139.

[5] Doodson, *op. cit.*

it appears reasonable to assume that the fluctuations of a longer period likewise are to be ascribed to changes in wind and weather.

In ascribing the fluctuations in sea level to effects of wind and weather it is tacitly assumed that the mean level of the sea with respect to a stationary coast remains fixed. But may not the mean level of the sea itself be changing, owing to a change in the volume of the ocean basins or to a change in the volume of the ocean waters? Daly has recently directed attention to the probability of a general sinking of sea level, during the human period, to the extent of about twenty feet.[6] Various causes may be mentioned as adequate to bring about a change in the absolute elevation of sea level, as, for example, crustal movements which bring about a change in the volume of the ocean basins; addition of water through volcanic action or subtraction of water through chemical binding during the alteration of rocks; decrease of water through increased glaciation on land or increase of water through decreased glaciation.

It is to be noted that changes in the absolute height of sea level can be distinguished from the fluctuations of sea level due to wind and weather; for, while the latter will necessarily be different on different coasts, the former will be characterized by a similar change over the entire world. Sea level determinations through tidal observations, therefore, furnish the data not only for determining changes in local relative elevation of land to sea but also, in a measure, of changes in absolute height of land and sea.

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[6] R. A. Daly: A General Sinking of Sea-Level in Recent Time, *Proc. Natl. Acad. of Sci.*, Vol. 6, 1920, pp. 246–250.

THE EXCHANGE OF POPULATIONS BETWEEN GREECE AND TURKEY

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During the last two years, 1922–1924, there has taken place in the Near East an event of capital geographical importance, the effects of which are just beginning to make themselves felt: I refer to the exchange of populations between Greece and Turkey, which involves close on 2,000,000 people and greatly surpasses this figure if Armenian refugees be included. In the course of a journey carried out last autumn I had the opportunity of observing this movement in progress and of gauging something of its consequences. I would here explain in what this exchange of peoples consists, under what conditions it has been effected, and what consequences have already resulted.

The People Exchanged

The "patchwork" distribution of peoples so characteristic of the Near East is a consequence of the policy formerly pursued by the conquering Turks. It sets out from a sufficiently liberal conception. The conquerors did not seek to convert the subjugated peoples to Islam. They enjoyed a sort of autonomy which allowed them to preserve their beliefs, their priests, and even a sort of civil organization. Whence it came about that in the Balkan Peninsula the number of Mohammedans has always been comparatively limited, while in Asia Minor the Christian element continued to form a respectable minority.

In Europe within the boundaries of the new Hellenic state, enlarged since 1913 by Epirus, southern Macedonia, western Thrace,[1] the islands of the Aegean, and Crete, the Mohammedan element was comparatively small—about 400,000 persons. There was only one group of any note, that of Crete consisting of some 25,000 individuals, who spoke Greek and led exactly the same kind of life as the population confessing the Orthodox religion. The centers of Moslem population of greatest numerical importance were in the north of Thessaly and especially in Macedonia round Saloniki, Kozani, Kayalar, Drama, Séres, and Kavalla. Epirus (Yanina) counted comparatively few. The greater number of the Moslems in Greece were old inhabitants of the country long since converted to Islam; they were often well to do and strongly attached to the soil of their ancestors.

The situation was distinctly different in Asiatic Turkey. There the Mohammedans formed the majority of the population, though many of

[1] The treaty of Sèvres (1920) gave eastern Thrace to Greece; the Treaty of Lausanne (1923) restored it to Turkey.

them were not of Turanian race but the ancient inhabitants who, since the beginning of the Mohammedan invasions, had by degrees passed over to Islam. By the side of these peoples dwelt groups of Christian peoples extremely compact and often extensive. In the east were the Armenians, whose numbers before the war can be estimated at some 2,000,000 on the eastern plateaus, without including the 200,000 to 300,000 established in the vilayets of Sivas, Trebizond, Angora, and Adana. Then came the Greeks, distributed chiefly along the coasts: a contingent of 150,000 to 200,000 in the region of Trebizond, smaller bodies on the southern coasts, and then a group of the first order on the western shores and plains—perhaps a million and a half from Brusa to the neighborhood of Rhodes. Add to this the interior centers—Greek and Armenian villages of Cappadocia and groups of Christians in each town. One might compare the scattering of the Greeks and Armenians across Asia Minor to the festoons of ivy that garnish the crevices of an old wall. Before the war the Christian elements of Asia Minor steadily gained ground at the expense of the Mohammedans, among whom the birth rate tended to diminish.

Lastly, Christians were very numerous in the old capital of the Empire. Constantinople, although the seat of Ottoman power, has never ceased to be partly Greek with Armenian suburbs. A census taken in 1924 gives to Stamboul, the most Turkish part of the town, nearly 100,000 Christians: adding those in the northern quarters and on the shores of the Bosporus, the number reaches 250,000 out of a total of 924,000. It is probable that before the war the Christian element represented one-third of the population of Constantinople.

The problem of the minorities (although it is less a matter of difference of race than of religion) does not then exhibit the same conditions in Greece and Turkey. In the case of the former only a few hundreds of thousands of peaceable citizens were concerned. In the case of the latter at least 3,000,000 people were involved, who more and more turned towards their brothers in Europe and whose sympathies went naturally to the enemies of the state. The Armenians had encouraged the Russian invasion in 1915, and the Greeks were in sympathy with the soldiers of Venizelos in 1920. The attempt of the Turks after 1908 to make all the subjects of the Empire loyal Osmanli had not succeeded. Furthermore, the Turkish leaders had rallied by degrees to the idea of reconstituting Ottoman unity by getting rid of the Christians. This idea dates from the Sultan Abdul Hamid: he had already applied it to the Armenians in the frightful massacres at the end of the nineteenth century. Other scenes of horror had distracted Cilicia at the beginning of the Young Turk régime. During the World War, extermination of the Armenians was practiced with a ferocity against which even Turkey's allies, the Germans, protested. Christian populations of Armenia were deported to Mesopotamia, most of these unfortunates perishing on the road. In 1919 and 1920 it was the turn of the Greeks of the Trebizond region, and they, with the last Armenians, were transported into

the mountains of Bitlis and, according to English and American witnesses, have also been exterminated. In Cilicia 80,000 Armenians fled to seek refuge in Syria when the French evacuated the province. The defeat of the Greek army in 1922 resulted in the mad flight of the greater part of the Greeks of the West.

Thus by 1922 the question of the Christian populations of Turkey had almost settled itself. But the men of Angora, inflexible in their logic, wished to complete their task. In the peace negotiations they demanded the expulsion of the Christian remnant from Turkey and the repatriation of the Mohammedans dwelling in Greece. The Powers granted these demands, and the Treaty of Lausanne (1923) drew up the conditions for the exchange of populations.[2]

Conditions of Exchange

The Treaty of Lausanne entrusted to the League of Nations the supervision of these vast movements of population that they might be accomplished under the best and most humane conditions. Dr. Nansen was designated High Commissioner to be responsible for the health conditions of the migration. At Constantinople a "Mixed Commission for the Exchange of Greek and Turk Populations," composed of members representing the High Contracting Parties to the Treaty and neutral powers and of Ottoman and Hellenic delegates, had its seat and also worked under the supervision of the League. These several bodies, however, were solely concerned with the migration. They had no responsibility for the settlement of the emigrants in the countries whither they were despatched, this being left to the respective governments. However, in Greece there existed an independent organization presided over by Mr. Morgenthau, former ambassador of the United States at Constantinople, which facilitated the establishment of the newcomers.

The Armenians

Let us now see how the actual exchange was effected, considering first the Christians and then the Moslems. We shall pass rapidly over the Armenians, with whose fate the Commission had no concern. What remains of this people is now dispersed in three chief regions. A certain number sought refuge in the eastern territory of Armenia, which remained in Russian hands and today constitutes the Armenian Socialist Soviet Republic. We have already stated that 80,000 passed to Syria where they have been settled in the Aleppo region. Some 65,000 from Cilicia, Trebizond, and western Asia Minor have sought refuge in Greece where their presence adds still further to the embarrassment of the Greek government. There still remain Armenians in Turkey, at Constantinople and even in Asia Minor, but we cannot even guess at their number. The fate of this race,

[2] Section VI, Convention Concerning the Exchange of Greek and Turkish Populations.

which has suffered such unparalleled persecutions and which remains so tenacious of life, is one of the most tragic circumstances of contemporary history.

The Greeks

The migration of the Greeks was carried out in various ways and is still not completed. The greater number of the Greeks fled precipitately in 1922 on the defeat of the Hellenic army, distressing scenes being witnessed especially in the burning of Smyrna. Gathered pell-mell on battleships, merchant ships, simple fishing boats and flung hastily on the islands adjacent to the Anatolian coast, in the Cyclades, in Attica, the refugees of 1922, being entirely destitute, experienced the utmost sufferings. It is only by slow degrees that they have been directed towards the Hellenic provinces where there are vacant lands, chiefly in Macedonia and western Thrace. They have, furthermore, suffered terribly from malaria.

Those remaining comprised two groups, that of Constantinople and that of Anatolia. Article 2 of the Treaty of Lausanne made exception of the Greeks of Constantinople, thus defined: "All Greeks who were already established before October 30, 1918, within the areas under the Prefecture of the City of Constantinople, as defined by the law of 1912, shall be considered as Greek inhabitants of Constantinople." Thus the greater number of its most industrious and richest inhabitants would be preserved to the city. However, the Turkish delegates on the Mixed Commission have raised difficulties regarding the term "established," being desirous of restricting its interpretation: the controversy concerns from 50,000 to 100,000 persons. In face of the opposition of the Greek delegation the dispute has been carried before the League of Nations. By November 25, 1924, 35,000 Greeks had already left Constantinople, to whom must be added 18,500 from the remainder of European Turkey.

In Asia Minor the exodus progressed regularly throughout the year 1924: 50,000 Greeks have left Cilicia, 8500 the Angora region, 31,000 the northern mountains. Those from the Diarbekr region obtained permission from France to pass through Syria. In October last I myself saw the trains of refugees in Cilicia. The sight of those freight cars in which were crowded together men, women, and children, with all their portable goods—straw pallets, bundles of clothing, queer assortments of provisions round which the wasps swarmed—struck pity to the heart. Yet these were the fortunate ones!

And so during the last two years there have arrived in Greece refugees estimated at 1,300,000 to 1,500,000; the higher figure being the more probable. In a report addressed to the League of Nations on March 10, 1924, the High Commissioner stated that two-thirds of the immigrants were destitute of all resources. It is not difficult to appreciate the terrible problem the arrival of these hordes presents to the Hellenic government. In the province of Macedonia alone there were 660,000 at the end of last summer, and the property evacuated by the Mohammedans sufficed for

scarcely 40 per cent of the newcomers. The work of feeding, clothing, and caring for them falls on a poor nation, suffering under recent military defeat and a sequence of disorganizing political events from the abdication of King Constantine to the proclamation of the Republic.

The Mohammedans

The task of Turkey would appear to be much easier. The number of newcomers to be installed was one-fourth to one-fifth that of Greece, and the exodus of the Christians leaves correspondingly abundant space for the repatriated Mohammedans. The movement has been effected in orderly fashion and not in the madness of flight. Yet things have gone even worse than in Greece.

The transportation of the Mohammedans from Greece to Turkey is now completed, and precise figures can be given: by November 25, 1924, it had reached 353,000 persons.[3] Many of them, it appears, went against their will. They were not illtreated in Europe and had no wish to be uprooted and transplanted to a ruined country. The conditions under which they have been received in Turkey have not mended matters. Under any circumstances it is a delicate business to carry out the movement of several hundreds of thousands of persons. But the administration charged with the task has certainly proved unequal to it. Nothing was prepared, it appears, save demonstrations of sympathy. The distribution of the newcomers seems to have been effected at haphazard. The destination of certain convoys, for instance, has been changed many times. In the localities assigned nothing was in readiness, and the *émigrés* last autumn had for several months been waiting definite allocation, some with Oriental fatalism, others with ever increasing exasperation.

Since the mass flight of the Greeks there have been sporadic outbreaks of fanaticism on the part of the Mohammedans, who have pillaged and destroyed abandoned houses of the Christians. At Uchak, for instance, the houses of the 3000 families in the Greek quarter having been burnt down, it was impossible to install the Mohammedans brought there, and they had to be sent on elsewhere. When the dwellings have not been fired they have frequently been despoiled of their doors, windows, in fact of everything removable. In the Murad quarter of Brusa I saw houses of Christians in the most lamentable condition. As the exodus of the Christian population took place almost 18 months before the arrival of the Moslems during which time the government took no steps for maintenance of the empty houses, for the most part fragile constructions of wood and earth, they have deteriorated; many are in ruins and must be completely rebuilt. It must also be admitted that before the arrival of the immigrants from Europe the best of the vacated dwellings, with the connivance of the Turkish

[3] The Moslems of western Thrace were excluded by the Treaty of Lausanne, and Moslem Greeks of Albanian origin have also been recognized as not subject to exchange.

administration in charge of the abandoned properties, had often been occupied by people who had no right to them.

For the most part the repatriated Moslems have had to be content with improvised accommodations, in which they are likely long to remain. I have seen them on the sidings of railway stations encamped in old German cars still bearing the label "Hilfslazaretszüge." Around Smyrna I have seen others lodged in tents: they had been there since the beginning of the open season, and it seemed likely they would spend the winter there too. In the city of Smyrna itself I came across them at every step lodged in excavations, in the cellars of burned houses, under temporary roofs made of pieces of sheet iron supported on stones. Furthermore, occupation of the abandoned houses has been forbidden until formal allotment has been made; and so slow are the administrative processes that the present situation bids fair to be perpetuated.

These deplorable conditions have had the most serious consequences for the poor people affected. They are the prey of every kind of illness. The Turkish newspapers cite the case of 120 families arriving from Macedonia and stationed without proper dwelling places at Ala Shehr, over 100 members of whom have died of exhaustion and disease. Of 900 sent to Seuké 250 had already died. Those who survive do not know what to do for a living. For the most part they are without money; they have no agricultural implements, no animals, often no dwelling. They resort to mendicancy while waiting for work which does not come. The Turkish government allows them a dole of 50 piasters (25 to 50 cents) a day, which is insufficient to live on and yet encourages a taste for idleness.

The newspapers discuss the problem vehemently, criticizing sharply the action of the government. They point out that £T10,000,000 (over $5,000,000) have already been expended but that this has merely served to increase the number of functionaries. From all points unfortunate incidents have been reported, arising out of the unsatisfactory condition of the *émigrés*.

Results of the Exchange to Greece

Considered in principle, the inequality of numbers and economic value of the exchanged populations being ignored, such an exchange of population would seem hazardous, especially as taking place between countries so poor and backward as Greece and Turkey. It is not easy to find in the country whither they are sent conditions closely similar to those in the country whence they came. Mountain folk, fishermen, and plains people are all involved. To select for them suitable environments in the new country presupposes a geographic and demographic inventory demanding much time and care, even in countries well studied, and this is not the case with either Greece or Turkey. Furthermore, Greece, as we have seen, received a great flood of refugees all at once and without preparation during

a period of internal chaos; Turkey with more time and smaller numbers found her administration inadequate to the task. The results of the exchange, therefore, could not fail to be unfavorable at the beginning. What, however, are the future prospects?

Of the two countries Greece undoubtedly finds the greater advantage. She has received a much larger number of inhabitants. As we have said, they may be estimated at about 1,500,000—a figure which will be further increased by the Christians removed from Constantinople. Now Greece has furnished in exchange only 353,000 Moslems. The transfer thus has enriched Greece with at least 1,100,000 people—a considerable figure for a country whose population in 1920 was estimated at 5,500,000.[4]

The majority of the transplanted Christians are agricultural peasants, an element in which Greece has never been very rich. The Greeks have always preferred the sea and trade, and they live by preference in towns. Even such rich land as the plain of Thessaly is still poorly cultivated. The basins of Macedonia have crying need for tillers of the soil, the more since the evacuated Moslems had been thus engaged. Of the 660,000 persons settled in Macedonia and western Thrace before the autumn, 420,000 came from agricultural districts. Greece cannot but gain by these immigrants, who in the country of their origin were reckoned the best agriculturists and had done much to promote the cultivation of the vine, olive, fig, and of cotton.

The newcomers also include artisans in industries unknown or little developed in Greece, for instance the silk weavers of Brusa and the carpet makers of the center and the east. Already statistics show progress in the export of carpets from Greece in 1924. Thus, despite the great difficulty that the Hellenic Republic has to face in absorbing these 1,500,000 new citizens, she is by them assured of new elements of prosperity.

Results in Turkey

Unhappily the same cannot be said of Turkey. She has lost in numbers and economic value. Since 1914 her losses in Christian population number at least 3,000,000. She has received 350,000 in exchange; the net loss exceeds 2,600,000. That is between one-fifth and one-sixth of the present population of the Turkish state. It is a frightful drain when one adds the ravages that twenty years of war have inflicted on the Moslem population. The loss is the more serious if the character of the element that is gone be taken into consideration.

The Armenians have everywhere been at the head of commercial operations, and these have languished since their departure. In some places, in Cilicia for example, the Armenians were clever cultivators. The Greeks were the most vigorous element of western Asia Minor in industry and agriculture as well as in trade. How can the sudden loss of these useful

[4] The Census of 1920 gives for the Old Territory 2,908,272; for the New (Macedonia, Epirus, Aegean Islands, western Thrace) 2,628,103.

members of the community be compensated? Without doubt the Moslems that were brought from Europe will be valuable additions. They are more laborious and enterprising than the native Turks of Asia Minor. Their Greek neighbors in Macedonia were genuinely congenial. But these newcomers are only 350,000 to fill a gap of 3,000,000.

Moreover, Asia Minor is at present in an anemic condition, recovery from which will be difficult. Debilitated by war and changes of government and accession of inexperienced officials, distrust of technicians and of foreign capital adds to the unfavorable conditions. The consequences of the exodus of the Christians are already keenly felt. At Brusa, where about 20,000 Christians have been replaced by some 2500 Moslems, industrial decline is clearly evident. The number of silk factories has fallen from 42 before the war to 23, the workers from 3500 to 1000, the production of raw silk (cocoons) from 2,800,000 kilos to 850,000 kilos. The owners also declare that the Moslem workers are much less efficient than the Christians whom they have replaced. In Cilicia, at Adana and Tarsus, the carpet manufacture was in the hands of the 50,000 to 60,000 Christians and has disappeared with them. The orange groves planted by the Armenians at Pajas have been abandoned. The same is the case at Konia; at Uchak the carpet industry is dead now that the Greeks have gone, and the vine cultivation is likely to perish. I have myself observed the decay of cultivation on the hills of Mudania, overlooking the Gulf of Gemlek; very few olive trees are being pruned, and the vines have been entirely neglected. At Smyrna the trade reports agree on the decrease of exports due to the reduction in numbers and the inexperience of producers. The situation will become still worse, for up to now profit has been drawn from the cultivations planted by those who have departed. The production of opium, olive oil, and cork oak bark is declining. It is remarkable also that the export of cereals, which amounted to 35,000 tons at Smyrna before the war, had completely ceased in 1923 and has been replaced by an almost equal importation. The disappearance of the Greek and Armenian merchants has completely upset the economic organization of the country; it has led to an abrupt diminution of the commerce of Smyrna, for the old clientele of the interior now deals with Constantinople, where Christian merchants are still installed at least for the time being.

These examples suffice to show that in expelling the Christians Turkey has launched upon a formidable venture. Without doubt she has realized or almost realized national unity, and that is a great asset for the future. But this unity is costing her dear: the remedy bids fair to kill the patient. The rulers of Turkey will need great application, care, and skill to heal the wounds they themselves have opened. At present it is yesterday's rival, Greece, that draws the most profit from the operation. Still one can at least hope that this great migration of people, effected at the cost of so much suffering, may be the beginning of a period of peace and reconstruction in the Near East.

RAINFALL CONDITIONS AS HANDICAPS TO TROPICAL DEVELOPMENT

WITH SPECIAL MENTION OF AUSTRALIA AND THE PACIFIC*

By Stephen Sargent Visher
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The most frequently mentioned asset of the tropics is the rapid growth of vegetation. Many loose estimates as to the great crop potentialities of certain tropical lands have been made, based upon the assumption that the average annual rainfall is well distributed or upon impressions gained in certain especially favored regions or in unusually favorable seasons. Such rosy estimates almost invariably fail to give sufficient weight to certain detrimental aspects of the rainfall conditions. The purpose of this paper is to point out and illustrate some of these aspects bearing on the development of the tropical lands. The paper is based on field work in the West Indies, the Pacific Islands, Australia, and the Far East and on extensive study of rainfall statistics.[1] Some of the data and conclusions have appeared recently in meteorological magazines.[2]

The rainfall of most of the tropics, as compared with that characteristic of middle latitudes, is far more variable from place to place, from season to season, and from year to year. Likewise a larger share of it falls in very heavy showers, reducing its usefulness. Indeed, during the wet season, the rainfall is frequently so excessive as to cause large portions of fertile alluvial valley flats to be flooded.

Variability in Regional Distribution

The rainfall of the tropics varies from region to region from more than 400 inches a year down to almost none. A large proportion of the tropical half of the world is distinctly arid, a still larger proportion is subject to severe drought. The normally rainy areas are mostly confined to narrow belts on the windward slopes of mountains, although some localities near the equator receive rain almost every day. The local contrasts in average rainfall are very great in most rugged tropical regions and are considerable in many areas where the relief is not more than a few hundred feet, especially if

* Read at the 21st Annual Meeting of the Association of American Geographers at Washington, D. C., Dec. 30, 1924–Jan. 1, 1925.

[1] The Pacific field studies were financed by grants from Yale and Indiana Universities and the Bishop Museum of Honolulu.

[2] S. S. Visher: Vergleichung der Niederschlagsveränderlichkeit in niedrigen und mittleren Breiten, *Meteorol. Zeitschr.*, Vol. 41, 1924, pp. 46–49.

Idem: Variability of Tropical Climates, *Meteorol. Mag.*, Vol. 58, 1923, pp. 121–125, 154–159, 178–179.

mountains are not far distant. Northeastern Queensland[3] and northeastern Brazil[4] furnish examples. Many islands illustrate clearly the sharp local contrasts in rainfall; for instance, the Hawaiian Islands.[5] Within the city of Honolulu alone the range in average rainfall is from less than 25 inches to over 90 inches at places of equal elevation only five miles apart. Also, within four miles of the central station with its 31 inches of rain, there is a station at an elevation of 1300 feet that receives an average rainfall of 106 inches.

Where sharp local contrasts in average rainfall obtain, the areas best adapted to a particular crop variety are commonly small and widely scattered, and it is hard to fit crop to rainfall type. The Hawaiian Sugar Planters' Association, for example, is experimenting with several hundred varieties of cane in an effort to find the best variety for each combination of climate and soil. Similarly dwellings, equipment, and methods that are satisfactory in one place often are misfits only a short distance away.

Seasonal Variation in Tropical Rainfall

The seasonal variation in rainfall is marked for the tropics as a whole, distribution throughout the year being less even than for the middle latitudes. Distinct wet and dry seasons are the rule. Most of tropical Australia, for instance, receives little rain for half the year. Darwin, Northern Territory, receives only 2.5 per cent of its annual 62 inches in the months May to September inclusive; Cloncurry, Queensland, with a total of 20 inches receives 11 per cent from May to October; Harvey Creek, Queensland, with the heaviest rainfall in Australia, 165 inches, has 15 per cent from June to October.[6] Hawaii and many other places near the margins of the tropics receive much of their rainfall in winter. The seasonal variation ranges from areas having only a very short rainy or dry season to those having half the year very wet and the other half very dry. Still other areas have two wet and two dry seasons. Most regions with only short wet or dry seasons have only a sparse population as compared with those having a long wet and dry season, provided the rainfall during the wet months is heavy. The dry season facilitates the preparation of the land for crops and gives a certain system to activity. But it has its disadvantages: high temperature causes rapid evaporation, desiccating the vegetation and soil, drying up water supplies, and oxidizing organic substances in the soil.

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[3] H. A. Hunt, Griffith Taylor, and E. T. Quayle: The Climate and Weather of Australia, Melbourne, 1913.
H. A. Hunt: Results of Rainfall Observations Made in Queensland, Commonwealth Bureau of Meteorology, Melbourne, 1914.
Griffith Taylor: The Australian Environment (Especially as Controlled by Rainfall), *Commonwealth of Australia Advisory Council of Science and Industry Memoir No. 1*, Melbourne, 1918 (summarized by S. S. Visher, in *Monthly Weather Rev.*, Vol. 47, 1919, pp. 490–494).

[4] Mark Jefferson: New Rainfall Maps of Brazil, *Geogr. Rev.*, Vol. 14, 1924, pp. 127–135.

[5] S. S. Visher: Local Climates in the Tropics, *Bull. Amer. Meteorol. Soc.*, Vol. 3, 1922, pp. 119–121. See also a recent analysis by A. J. Henry: Hawaiian Rainfall, *Monthly Weather Rev.*, Vol. 53, 1925, pp. 10–14.

[6] From tables in Hunt, Taylor, and Quayle, *op. cit.*

In order to compare the monthly variability of rainfall in low and middle latitudes, a planimeter measurement was made of Supan's Map of Percentage Range of Mean Monthly Rainfall in Bartholomew's Atlas of Meteorology. This map shows four types of regions: (1) where the wettest month is less than 10 per cent rainier than the driest month; (2) where

TABLE I—PERCENTAGE RANGE OF MEAN MONTHLY RAINFALL, LATITUDE 30° TO 60°

CONTINENT	RANGE LESS THAN 10 PER CENT		RANGE 10–20 PER CENT		RANGE 20–30 PER CENT		RANGE OVER 30 PER CENT	
	MIL. SQ. MI.	PER CENT	MIL. SQ. MI.	PER CENT	MIL. SQ. MI.	PER CENT	MIL. SQ. MI.	PER CENT
Europe	1.77	65	.88	34	.03	1	0	0
N. America . .	2.06	43	2.62	54	.14	3	0	0
S. America . . .	.23	26	.55	60	.13	14	0	0
Asia	.22	3	2.65	34	3.75	49	1.13	14
Africa	.05	15	.23	44	.47	41	0	0
Australia . . .	.36	47	.40	53	.005	.6	0	0
Total and Means	4.70	26	7.33	42	4.53	25	1.13	7

TABLE II—PERCENTAGE RANGE OF MEAN MONTHLY RAINFALL, LATITUDE 30° N. TO 30° S.

CONTINENT	RANGE LESS THAN 10 PER CENT		RANGE 10–20 PER CENT		RANGE 20–30 PER CENT		RANGE OVER 30 PER CENT	
	MIL. SQ. MI.	PER CENT	MIL. SQ. MI.	PER CENT	MIL. SQ. MI.	PER CENT	MIL. SQ. MI.	PER CENT
N. America . .	0	0	.46	39	.70	61	0	0
S. America . . .	.12	2	4.91	76	1.31	21	.04	1
Asia	.10	2	.96	23	2.56	60	.63	15
Africa	0	0	2.28	20	8.86	78	.21	2
Australia . . .	.16	7	.63	28	1.32	59	.13	6
East Indies . . .	.43	36	.72	63	.01	1	0	0
Total and Means	.81	3	9.96	38	14.76	55	1.01	4

the wettest month is from 10 to 20 per cent rainier than the driest; (3) where the range is from 20 to 30 per cent; and (4) where it is over 30 per cent. Tables I and II show the approximate area and the percentage of each type by continents, Table I for middle latitudes (30° to 60°), Table II for low latitudes (30° N. to 30° S.).

These tables indicate that low latitudes have over three times as large an area possessing a monthly variability of over 20 per cent as have mid-latitudes, and twice as large a percentage of their total area has this range.

The one large area in mid-latitudes mapped as in the fourth, the most extreme type of rainfall variability, is the little-known Tibetan Plateau, which has little agricultural value because of its great altitude. Furthermore, the month of least precipitation over large areas in mid-latitudes commonly is in the winter season when plants require little moisture. On the other hand, the driest month of the tropics is also a hot month, with active evaporation. This combination is responsible for the lack of forests in many places having a large annual rainfall. For instance, parts of tropical Australia having over 50 inches of rain a year possess no real forest because several months are extremely dry and hot. This is the case in that part of Northern Territory which Griffith Taylor has named "Darwinia." The sterile nature of the soils in large sections of the region, a contributory factor, is also due in part to the rainfall régime.[7] The temperature for the dry months at Darwin, May to September, averages about 80° F.

In respect to the more uniform rainfall type, where the range between the driest and wettest months is less than 10 per cent, mid-latitudes have nearly six times as large an area as low latitudes. This type comprises about 26 per cent of the total land area of mid-latitudes, while it makes up only 3 per cent of low latitudes. Other interesting comparisons come out on further study of these tables.

Variability of Rainfall of Tropical Cities

To compare the variability of rainfall in the tropical half of the globe with that of higher latitudes I have examined the official records for many cities in both zones.[8] The selection was impartial, being determined solely by the availability of the data. The comparison is between the greatest and least annual precipitation officially recorded before a recent year (in some cases 1922, in others 1912 or earlier). The length of the record varies, but in general it is shorter in low latitudes than in higher latitudes and hence tends to lessen the apparent range in lower latitudes. Tables III and IV give the figures to the nearest tenth of an inch. It will be noticed that the maximum amount of rainfall received in a year was less than twice the minimum for Chicago, Edinburgh, Oslo (Christiania), Ottawa, Paris, Peking, and Tokyo and only a trifle more than twice the minimum in the case of Amsterdam, Berlin, Berne, London, New York, Petrograd, St. Louis, and Wellington. Very few middle or high latitude cities appear to have experienced three times as much precipitation in their wettest year as in their driest. Madrid, Washington, and Vladivostok are exceptions, as are some cities in southern Europe; while Hobart, Buenos Aires, Rome, and

[7] Taylor: Australian Environment, p. 68.

[8] The data concerning these cities were obtained from several sources, especially H. A. Hunt: The Climate and Meteorology of Australia, Melbourne, 1920; H. J. Cox and J. H. Armington: The Weather and Climate of Chicago, *Bull. Geogr. Soc. of Chicago No. 4*, Chicago, 1914; José Coronas: The Climate and Weather of the Philippines, 1903 to 1918, Manila, 1920; A. J. Henry: Climatology of the United States, *U. S. Weather Bur. Bull. Q*, 1906; and Julius Hann: Handbuch der Climatologie, Stuttgart, 1910 (averages). Numerous lesser official sources were consulted to extend the records or to add additional ones.

San Francisco are notable for having received about four times as much. However, the situation of the last three cities is marginal. Madrid and Vladivostok with an average rainfall of less than 20 inches are more subject to large percentage changes than where the normal rainfall is larger.

TABLE III—EXTREME ANNUAL RANGE OF RAINFALL IN MID-LATITUDES

CITY	LATITUDE	AVERAGE RAINFALL	DRIEST YEAR	WETTEST YEAR
Amsterdam . . .	52° N.	27.3 in.	17.6 in.	40.6 in.
Berlin	53° N.	23.0	14.3	30.0
Berne	47° N.	36.3	24.7	58.2
Buenos Aires . .	35° S.	36.8	21.5	80.7
Chicago	42° N.	33.5	24.5	45.9
Edinburgh . . .	56° N.	25.2	16.4	32.1
Hobart	43° S.	23.7	13.4	43.4
London	51° N.	24.0	18.2	38.2
Madrid	40° N.	16.2	9.1	27.5
New York . . .	41° N.	42.5	28.8	59.7
Oslo (Christiania)	60° N.	22.5	16.3	31.7
Ottawa	45° N.	33.4	26.4	44.4
Paris	49° N.	21.9	16.4	29.6
Peking	40° N.	24.4	18.0	36.0
Petrograd	60° N.	21.3	13.8	29.5
Rome	42° N.	32.6	12.7	57.9
St. Louis	39° N.	37.4	23.4	49.2
San Francisco . .	38° N.	22.8	9.3	38.8
Tokyo	36° N.	59.2	45.7	77.1
Vienna	48° N.	24.5	16.5	33.9
Vladivostok . . .	43° N.	19.5	9.4	33.6
Washington, D. C.	39° N.	43.8	18.8	61.0
Wellington. N. Z.	41° S.	49.7	30.0	67.7

Turning now to the lower latitudes, we find that among 14 scattered cities having 30 inches of rainfall or more, on the average, in no case was the officially recorded rainfall of the wettest year less than twice that of the driest. Only in Calcutta and Caracas did the ratio fall as low as 2¼. In Johannesburg it was 2½ times as great; and in Durban, Hongkong, and New Orleans it was 2¾ times as great. In Colombo and Honolulu it was about 3 times, in Bombay and Manila each about 3½ times, in Madras 4½ times, in Brisbane and Singapore 5 times, and in Fortaleza 6 times as great. All these cities have a normal rainfall of 30 inches or over, and the mean for the group of cities is 57.8 inches in contrast with a mean of 30.5 inches for the cities of Table III. Since percentage fluctuations tend to become smaller as the total rainfall increases, the great fluctuations experienced by these tropical cities are all the more notable.

If tropical and subtropical cities having an average rainfall of less than

20 inches are included in the comparison, even more violent ranges are disclosed. For example: Cairo, Egypt, and San Diego, Cal., each have received about 6⅓ times as much rainfall in their wettest year as in their driest; Athens has received 7 times as much; Helwan, Egypt, 18 times as much; and Onslow, a small port of Western Australia, 47 times as much.[9]

TABLE IV—EXTREME ANNUAL RANGE IN RAINFALL IN LOW LATITUDES

CITY	LATITUDE	AVERAGE RAINFALL	DRIEST YEAR	WETTEST YEAR
Bombay	19° N.	71.1 in.	33.4 in.	114.9 in.
Brisbane	27° S.	45.6	16.2	88.3
Calcutta	23° N.	62.0	39.4	89.3
Caracas	11° N.	30.0	23.7	47.4
Colombo	7° N.	83.8	51.6	139.7
Durban	30° S.	40.8	27.2	71.3
Fortaleza (Ceará)	4° S.	55.8	18.3	109.0
Hongkong . . .	22° N.	84.1	45.8	119.7
Honolulu	21° N.	31.3	14.6	45.0
Johannesburg . .	26° S.	31.6	21.7	50.0
Madras	13° N.	49.0	18.5	88.4
Manila	15° N.	76.3	35.7	117.0
New Orleans . .	30° N.	55.7	31.1	85.7
Singapore	1° N.	92.0	32.7	158.7

None of the cities of Table IV, except Singapore, happens to be close to the equator, the necessary data for other equatorial cities not being readily available. However, extreme fluctuations occur almost under the equator, even on oceanic islands. At Malden Island (latitude 4° 1′ S., longitude 155° W.) for example, the annual totals of rainfall have varied from 3.95 inches in 1908 to 63.41 inches in 1905. At Oceanic Island (latitude 0° 52′ S., longitude 169° 35′ E.), nearly 2000 miles west of Malden Island and within a degree of the equator, the range has been between 19.61 inches in 1909 and 158.93 inches in 1905 (141.12 in 1911). There was likewise in number of rainy days a range from 74 in 1910 to 232 in 1911.[10] In the Hawaiian Islands, Puuhela on Maui (latitude 20¾° N., longitude 156½° W.) received only 2.46 inches of rain in 1912 while it had 33.14 inches in 1918. Many other Hawaiian stations show a somewhat similar range, and the rainfall of the group as a whole is characterized by the government meteorologist as "extremely unreliable."[11]

The great variability illustrated by these three mid-Pacific islands is the more notable because insular climates are commonly described as

[9] Data for Cairo and Helwan from *Meteorol. Office Publ. 225i*, London, 1918. Data for Onslow from Taylor, Australian Environment.

[10] Data for Malden and Oceanic Islands supplied and vouched for by H. A. Hunt, Commonwealth Meteorologist, Australia.

[11] Data supplied by L. H. Daingerfield, in charge of the Hawaiian service, U. S. Weather Bureau, 1918–1922.

exceptionally uniform, particularly if the islands lie near the equator, are not dominated by near-by continental masses, and are not within hurricane regions. None of these three is in a hurricane region, all are far from a continent, and two are close to the equator.

The frequent famines caused by droughts or floods in India and China are well-known evidences of unreliable rainfall. Tropical Australia has perhaps even worse droughts and floods and is saved from terrible famines only by the sparseness of the population and the skill used in reducing losses to a minimum. The annual variation at Onslow, for instance, was from 0.57 inch in 1912 to 26.96 inches in 1900. Examples of less extreme contrast are numerous. The drought of 1918–1919 reduced the average yield from three million acres of wheat in New South Wales to one quarter of the normal. The great drought culminating in 1902 reduced the number of sheep in Australia from 95 millions to 55 millions. A drought period about 1914 reduced them from 93 millions to 69 millions.[12]

Heavy Rainfalls

Excessive falls in short periods afford another type of illustration of the uncertainty of tropical rains. For example: in tropical Australia, on more than 400 days in a 25-year period, more than 10 inches of rainfall fell in 24 hours, according to the total official rainfall records, while in temperate Australia there have been very few recorded instances of such heavy rainfalls—none in Victoria or South Australia and only two in Tasmania (maximum of 18.1 inches in three days). In tropical Australia more than 20 inches has been officially recorded as falling in 24 hours on 42 different days, and more than 30 inches on four occasions. The maximum was 35.71 inches at Crohamhurst, Queensland, on February 2, 1893. However, 60 inches fell in three consecutive days at Mt. Molloy, Queensland, and there have been many 48-hour periods when more than 25 inches fell.[13]

At Suva, Fiji, it frequently happens that more than 10 inches of rain falls within 24 hours; there were four cases in the seven years from 1905 to 1912. The maximum reported has been 26.5 inches in less than four hours on August 8, 1906.[14]

What is believed to be the world's record for officially measured rainfall in 24 consecutive hours (1168 millimeters, 46 inches) occurred near Manila on February 14–15, 1911. The other stations at which this maximum has been approached are also in low latitudes, namely: Cherrapunji, India, on June 14, 1876, 40.8 inches; Silver Hill, Jamaica, in November, 1909, 57.5 inches in 48 hours; Funkiko, Formosa, 40.7 inches on August 31, 1911, and Honomu, Hawaii, 31.9 inches, on February 20, 1918.[15]

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[12] Griffith Taylor: Agricultural Climatology of Australia, *Quart. Journ. Royal Meteorol. Soc.*, Vol. 46, 1920, pp. 331–356. See also *Official Year Book of the Commonwealth of Australia No. 16*, Melbourne, 1923.

[13] *Official Year Book of the Commonwealth of Australia No. 14*, Melbourne, 1921, pp. 60–64.

[14] Annual Reports of the Superintendent of Agriculture, Suva, Fiji.

[15] All from Coronas, *op. cit.*, p. 100.

With such sharp annual and daily extremes as these it is reasonable to expect great monthly extremes. At Malden Island (mentioned above), for example, the range in officially recorded rainfall from 1890 to 1918 is shown in Table V.

Table V—Monthly Variation in Rainfall at Malden Island (Inches of Rain)

Month	Minimum	Maximum	Month	Minimum	Maximum
January . . .	0.00	19.48	July	0.59	10.10
February . .	0.00	9.27	August . . .	0.18	5.56
March . . .	0.15	25.65	September . .	0.05	3.03
April	0.47	12.34	October . . .	0.00	5.27
May	0.29	12.30	November . .	0.00	8.72
June	0.00	12.49	December . .	0.00	8.20

The four months November, 1891, to February, 1892, received a total of only 0.72 inch, while the four months January to April, 1915, received over 60 inches. The number of rainy days a year varied from 30 to 144.

At Oceanic Island, likewise, the monthly ranges are extreme. Within a nine-year period February, March, April, and November have each received 0.1 inch or less and also 21.3 inches, 28.9 inches, 27.6 inches, and 15.5 inches respectively, and falls of 0.7 inch or less in May, August, September, October, and December are to be contrasted with falls of from 12 to 19 inches received in other years in the same months.

The Philippines show scarcely less violent extremes. In the 16-year period 1903–1918 two-thirds of the 70 stations had a total of about 160 months with no rainfall, while at the other extreme the wettest months at about half of the 70 stations exceeded 40 inches of rain and had less than 20 inches in the case of only eight stations. This variation is only partly seasonal, for a month which is very dry in one year may be exceedingly wet in another. Severe and widespread droughts, with over 100 days without rain, are contrasted with destructive floods caused by rainfalls of more than 20 inches in a day or two.[16]

Even at Hilo, on the wet side of Hawaii, where the rainfall averages 139.4 inches a year and is relatively reliable, a 13-year period shows that the monthly amounts have varied widely; for example, January from 0.5 inch to 36.6 inches, February from 1.9 to 32.5 inches, March from 2.9 to 45.4 inches, April from 3.7 to 25.1 inches, and December from 1.7 to 27.8 inches.[17]

That the great variation from year to year in rainfall, discussed in the foregoing pages, is not local is suggested by various data. For example, the average rainfall of the entire Hawaiian group (150 stations) was more

[16] Coronas, *op. cit.* See also his "The Extraordinary Drought in the Philippines, October, 1911, to May, 1912," Weather Bureau, Manila, 1912.

[17] Data from the U. S. Weather Bureau, Honolulu Office.

than twice as great in 1919 as in 1918 (112.9 inches compared with 54.5 inches). Likewise, in the Philippines during the droughts such as that referred to in a preceding paragraph most of the 70 stations were affected similarly.

Another unfavorable aspect of tropical rainfall is the rate of fall. In general, in low latitudes, much of the precipitation occurs during local thunderstorms, and heavy falls occur suddenly. A few minutes after a downpour the sun often shines hotly. Even on the windward slopes of mountains in the trade-wind belt much of the rain falls in sharp showers. In middle latitudes, on the other hand, a much larger proportion of the precipitation occurs in general rains when, for several hours or occasionally for several days, a gentle fall occurs. Therefore a larger percentage of the fall has time to soak into the ground in mid-latitudes than in low latitudes, and there is correspondingly less run-off and less soil erosion and leaching. Hence, in middle latitudes, a larger share of the rainfall normally is available for the plants than in the tropics. Likewise, because of slower evaporation, less moisture is required.

Thus it appears that the development of many tropical regions is rather seriously handicapped by rainfall conditions, and, before these regions can be developed advantageously, the rainfall conditions must be well known and adjustments to them wisely worked out. This will require much co-operation. The writer is beginning a special study of rainfall conditions in tropical America and will appreciate suggestions and data.

GRAVITY DETERMINATIONS AT SEA

By C. H. Swick
U. S. Coast and Geodetic Survey

If all the oceans were filled with islands as close together as in certain parts of the Pacific and Indian oceans, perhaps the geodesists would be satisfied to measure the intensity of gravity at land stations only. There are, however, great ocean areas containing no islands, and the determination of gravity over these areas is a very difficult problem.

At the present time the only method of determining the intensity of gravity with high precision is by the use of pendulums. But gravity pendulums cannot be used on an ordinary ship, not only because the motion of the ship displaces the pendulum on its support but also because the pendulum will measure both the acceleration of gravity and the vertical acceleration of the ship and the two effects cannot be separated. During the past twenty-five years several attempts have been made to design some type of apparatus that could be used at sea and give an accuracy comparable with that obtained on land with the pendulum apparatus. The net result has been perhaps two different types of sea apparatus which can be used with fair success. They do not, however, give the accuracy required for the scientific study of the isostatic condition of the earth's crust.

Apparatus Designed for Use on Submarine

About two years ago Dr. F. A. Vening Meinesz, Engineer to the Dutch Geodetical Committee, became interested in the problem[1] and after a careful study came to the conclusion that pendulums might possibly be used at sea if they were swung on a submerged submarine. He found, however, from theoretical considerations that special methods should be employed to eliminate the effect of small accelerations of the ship which are sure to occur even in a deeply submerged submarine. The Von Sterneck pendulum apparatus seemed well adapted to the purpose, for Dr. Meinesz found that if two pendulums are swung simultaneously in parallel planes, preferably in opposite phase, the results can be used in computing an ideal pendulum which will be free from the effects of small accelerations of the ship. The Von Sterneck apparatus is so arranged that four pendulums may be swung at one time in two pairs, each pair swinging in parallel planes and with the two pairs of planes at right angles to each other.

Instead of the ordinary coincidence method for comparing the periods of the pendulums with a chronometer, a photographic apparatus was

[1] See F. A. Vening Meinesz: Observations de pendule sur la mer pendant un voyage en sous-marin de Hollande à Java, Commission Géodésique Néerlandaise, 1923; also the accounts by J. J. A. Muller in *Nature*, No. 2811, Vol. 112, 1923, Sept. 15, p. 393; No. 2822, Vol. 112, 1923, Dec. 1, p. 788; No. 2835, Vol. 113, 1924, Mar. 1, p. 308; No. 2844, Vol. 113, 1924, May 3, p. 641; and No. 2893, Vol. 115, 1925, Apr. 11, p. 550.

designed to record the oscillations of the pendulums automatically and thus not only increase the accuracy of the observations but also decrease the time required for a gravity determination. As a submerged submarine cannot be held at a given depth except when under way, it is necessary that the determination be made quickly or else that the submarine stay near the same spot by laying a course in the shape of a figure 8 during the observations. The latter alternative would add considerably to the expense and might not be feasible in all cases.

Tests Made in 1923

In the summer of 1923 the Dutch Navy sent three submarines and a mother ship from Holland to Java, and Dr. Meinesz was given an opportunity to make a thorough test of his apparatus. During the first part of the trip the sea was quite rough, and contrary to expectations the submarine had too much roll even when 25 or 30 meters below the surface to permit observations. It was found that the pendulums could not be swung successfully if the roll was more than 1°.

The first set of observations was made off the south coast of Portugal at a depth of 25 meters in a calm sea on September 26, 1923. Later in the same day two more sets were made about 25 miles from the first. About 20 minutes were taken for each set. Nothing more was done in the Atlantic.

At Gibraltar, Dr. Meinesz with the coöperation and help of the British authorities, constructed a device for suspending the whole apparatus from a horizontal axis placed lengthwise in the ship. This proved to be a very great help, as during the remainder of the trip to Java no observations were prevented by the movements of the ship. The pitching of the ship was ordinarily small and, when necessary, could be made still smaller by use of the horizontal rudder and so gave no trouble. In the Red Sea an attempt was made to obtain a set of observations at the surface. Although the sea at the time was smooth and calm, the vertical acceleration of the ship was much too large for accurate work.

It was found during the work in the Indian Ocean that a heavy swell extends to a much greater depth than do wind waves and was often troublesome even at a depth of 20 meters. The observations in the Indian Ocean would have been made at a greater depth than they were but for the fact that a small leak in the submarine gave trouble when the submergence was greater than about 20 meters. It was found desirable to submerge as deeply as possible and thus keep the movements of the ship caused by swells and waves very small even though the effect of these movements was practically eliminated by the method of swinging the pendulums in pairs.

An interesting check on the accuracy of the observations was obtained by a study of the Eötvös effect when the ship's course was changed from west-east to east-west. When the ship was moving toward the east the

total centrifugal force in opposition to the gravitational attraction of the earth was, of course, greater than that due only to the rotation of the earth, and the measured intensity of gravity became less than normal. The reverse was the case when the ship was moving toward the west. It was possible to compute the speed of the ship within 0.3 mile per hour of its correct value by noting the difference of gravity as measured in the two directions. Although the gravity observations were corrected for the Eötvös effect due to the speed of the ship through the water, the Eötvös effect due to current could not be entirely eliminated on account of lack of information. A correction could be applied only for the approximate average velocity of the current.

Dr. Meinesz had two sets of pendulums with him, one of bronze and the other of invar. Owing to the strong magnetic field of the submarine the invar pendulums could not be used at sea. But for this fact better results could have been obtained as the arc lamp, which was the source of light for the photographic apparatus, caused large variations in the temperature and resulted in much greater uncertainties in the periods of the pendulums than would have been the case if the invar pendulums could have been used. In the Red Sea, the temperature inside the submerged submarine was 100° F. and was much higher than that under the black cloth placed over the whole apparatus to screen out extraneous light from the photographic apparatus. These were very trying conditions for the observer as well as for his pendulums.

Success of the Determinations

Altogether Dr. Meinesz made nearly thirty determinations of gravity at sea during the trip. In addition he made five determinations at ports along the way. The mean error of his results, uncorrected for effect of current, is less than 0.005 cm/sec^2. His actual errors are probably not much larger than 0.010 cm/sec^2 and are undoubtedly smaller than for any other sea determinations. They compare quite favorably with errors of land observations, which are usually between 0.001 and 0.003 cm/sec^2. To illustrate what this accuracy means it may be stated that an error of 0.001 cm/sec^2 in gravity corresponds to an error of about 0.00000025 second in the absolute period of the quarter-meter pendulum. Dr. Meinesz was fortunate in having an excellent chronometer for use in obtaining the periods of his pendulums. The rate of this chronometer, which seldom varied more than 0.1 second a day, was determined by means of radio time signals from Paris, Lyons, or Bordeaux for the western part of the trip and from Calcutta for the eastern part.

The Coast and Geodetic Survey has undertaken to compute the isostatic and topographic corrections for the sea gravity determinations made during this trip from Holland to Java. Interesting results are being obtained especially in the Indian Ocean, which seems to be very closely in isostatic equilibrium contrary to the expectations of many geodesists.

Future Work

Dr. Meinesz expects to make more gravity determinations at sea in the near future on a trip across the Atlantic, through the Panama Canal, and across the Pacific to Java. It is hoped that this important scientific work will go on as rapidly as possible and that the navies of many other countries will engage some of their submarines in this valuable peace-time occupation. A number of accurate gravity determinations at sea well distributed over the great ocean areas would aid materially in solving questions about the formation of islands and mountains, the cause and prediction of earthquakes, movements of continents, the isostatic condition of the earth's crust, and similar interesting problems.

THE INTERNATIONAL GEOGRAPHICAL CONGRESS AT CAIRO

By H. Baulig
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The Eleventh International Geographical Congress, held at Cairo from April 1 to April 9, 1925, follows the Congress of Rome, 1913, renewing a tradition broken by the war and, one may hope, inaugurating a new period.

The initiative for the convocation[1] belongs to the Geographical Society of Cairo (in sequence Khedival, Sultanic, Royal), which celebrates in 1925 the fiftieth anniversary of its foundation. In the execution of the plan its active and devoted General Secretary, Adolphe Cattaui Bey, was seconded by the personal sympathy of King Fuad I and by the support of the Egyptian Government, which saw therein a manifestation of intellectual emancipation. The event of the Congress is always invested with a good deal of circumstance and publicity. For a fortnight the native and western press devoted entire pages to chronicling the doings of the Congress. A special postage stamp was issued, and a medal was struck bearing the effigy of the King. The Congress was sumptuously entertained at banquets, fêtes, and receptions.

Procedure of the Congress

To the call of the organizers there had been a gratifying response. At the meeting itself nineteen states were officially represented: Argentina, Belgium, Brazil, Czechoslovakia, Egypt, France, Great Britain, Greece, India, Italy, Japan, Lithuania, Morocco, Palestine, Persia, Poland, Portugal, Spain, Switzerland. Nationals of eleven other states, including Canada and the United States were also present. Thus, although the Congress was hardly universal, it had at least a broadly international character. At least 250 persons attended and took a more or less active part in the procedure. This procedure was on the order of other Congresses. The 121 communications presented to the several sections were classed as Mathematical Geography, Geodesy, and Cartography, 11; Physical Geography, 38; Biogeography and Human Geography, 22; Anthropology and Ethnography, 15; History of Geography and Historical Geography, 35.

The subjects treated were most diverse. The greater number did not appear to the writer to have an unquestionably general interest or a particular interest for the geography of Egypt. In any case few gained anything by being thus produced under an exotic sky, and they would assuredly

[1] On the circumstances of this convocation see "The Future of International Congresses" *Geogr. Journ.*, Vol. 61, 1923, pp. 440–443 and *ibid.*, Vol. 64, 1924, p. 270.

have reached the interested reader as well by the ordinary channels. We shall return later to this point, which calls for radical reform.

More interesting were the resolutions adopted by the sections or in plenary session under the gracious and distinguished presidency of General N. Vacchelli, Director of the Istituto Geografico Militare of Florence. These resolutions dealt with (1) the extension, thanks to international agreements, of the *Bibliographie Géographique*;[2] (2) the progress and standardization of the International Millionth Map of the World; (3) the resumption under the auspices of the International Geographical Union of the "Atlas des Formes du Relief," by Jean Brunhes, Émile Chaix, and Emmanuel de Martonne; (4) the publication, with the documentary bases, of a map of the regions of interior drainage carried out under the direction of Emmanuel de Martonne and presented by him;[3] (5) integral publication of the lists of soundings on which is based the second edition, now almost completed, of the Prince of Monaco's "Carte Générale Bathymétrique des Oceans"; (6) creation of an International Commission for study of the Red Sea; (7) recovery of geographical data contained in papyri; (8) a critical edition of the cartographical work of the great Arabic geographer, Idrisi.

The Congress has been the occasion of an important publication by Prince Omar Toussoun.[4] Reference may also be made of the award of the Geographical Society of Philadelphia's medal to Hassanein Bey for his explorations in the Libyan Desert.

In the rooms of the Geographical Society at Cairo were installed exhibitions from the Physical Department[5] (meteorology, hydrology, chemistry); from the Department of Agriculture (cultivated plants, diseases, parasites, etc.); and from the Survey of Egypt, which showed its cadastral surveys on the scale 1:1000 and maps in 1:5000, 1:25,000, and 1:100,000 obtained by successive photographic reductions following revisions on the ground. In passing we may also note the map in 1:250,000 of the whole of inhabited Egypt and the map in 1:500,000 of the deserts—this last a reconnaissance map. A few steps from the building of the Geographical Society is the permanent exhibition of the Geological Survey where are minerals, rocks sculptured by desert erosion, and splendid specimens of the celebrated Tertiary fauna of Fayum.[6]

The Museum of Egyptian Antiquities in Cairo in its admirable collection offers a résumé of the art of ancient Egypt from the Stone Age to the

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[2] Agreements have been made, as is known, with the American Geographical Society, which collaborated in the publication of the *Bibliographie* for 1923, and with the Comitato Geografico Italiano; negotiations are being satisfactorily pursued with the British and Belgian national committees.

[3] See the note, "The Area of Interior Basin Drainage," in this number of the *Review*.

[4] Mémoire sur l'histoire du Nil: Mémoire présenté au Congrès International de Géographie et publié sous les auspices de Sa Majesté Fouad I[er], roi d'Egypte, 1925, 2 vols., 264 and 543 pp., and atlas of 22 sheets.

[5] The Physical Department published on the occasion of the Congress an interesting memoir by its director H. E. Hurst: A Short Account of the Nile and its Basin, 1925, 19 pp., with map in 1:7,500,000.

[6] While the Congress was in session the Geological Survey published an important work by its director W. F. Hume: Geology of Egypt, Vol. 1: The Surface Features of Egypt, Their Determining Causes and Relations to Geological Structure, xliv and 408 pp.; maps, diagrams, ills., bibliogr., index, 1925.

Alexandrine and Christian epochs. The city of Cairo itself, one of the religious and intellectual capitals of Islam, possesses in its mosques and mausoleums some of the major works of Mohammedan art.

The excursions which took place, some during, some after the Congress, had for object the introduction of the visitor to some of the most striking aspects of nature or to certain masterpieces of ancient art. Short excursions of a day or half-day led to the Pyramids, to Sakkarah (near ancient Memphis), to the Delta barrage, to Ismailia, and to Port Said. Some of the delegates visited on their own account the Wadi Natron, a closed depression of the Libyan Desert, the plateau of Mokattam, which dominates Cairo to the east; the classic Wadi Hof near Helwan, studied, described, and mapped by Schweinfurth; and the orchards of Fayum. Some also went from Cairo to Suez by the ancient route of the India mail.

The principal excursions, which unfortunately were simultaneous, had Upper Egypt for objective. The valley of the Nile was ascended to Luxor, on the site of ancient Thebes, whence one route led to the first cataract at Aswan. An alternative was by rail to the oasis of Kharga in the Libyan desert, and another by automobile from Qena on the Nile to Kosseïr[7] on the Red Sea.

The route up the Nile valley is comparatively well known; the other two routes, less known, led into two entirely different countries. To the west of the Nile extends a vast calcareous plateau, broadly horizontal in spite of numerous faults of small amplitude, the surface absolutely desolate *hamada*, swept by the wind and apparently without trace of recent fluvial erosion.[8] The oasis of Kharga occupies a small corner of a vast closed depression with abrupt sides, corresponding probably to a slight anticline. The bottom consists of Nubian sandstone containing artesian water which is fed by rains in the Sudan or infiltrations from the Nile.

The eastern desert of Egypt offers an entirely different field. It is composed essentially of a mountainous zone of crystalline and metamorphic rocks flanked by bands of Nubian sandstone and Cretaceous and Eocene limestones. Although the country is desertic in the highest degree, traces of fluvial erosion are everywhere apparent in the deep ramifying valleys emptying to the Nile or the Red Sea and in the broad beds of wadi choked with alluvium out of which rises the dominating rocky relief. Mechanical degradation is everywhere in evidence in the bare surface of slopes and summits, in the bold and often bizarre forms, in the vast talus accumulated at the foot. Evidences of chemical erosion abound, in the limestones and gypsums, under the form of lapies.

Egypt's Population Problem

But the geography of Egypt presents problems of another order, on

[7] The excursion from Qena to Kosseïr had been organized with great care by the Director of the Società Egiziana di Fosfati, Signor Decima. It was directed on the scientific side by Dr. Hume.

[8] See E. F. Gautier: Nomad and Sedentary Folks of Northern Africa, *Geogr. Rev.*, Vol. 11, 1921, pp. 3–15 and references.

which many of the visitors would have liked to have had more information. The population of this country approaches 14,000,000, or more than 400 per square kilometer of useful surface. This country, purely agricultural, with no industry of importance and knowing no relief from emigration, has a density at least equal to that of the larger part of the most industrialized areas of Europe and greater than that of Rhode Island.

One can only fear that increase will continue. The population grows rapidly: it has doubled in the last 40 years. It is true that the cultivated area increased from 23,000 square kilometers in 1892 to 31,000 in 1917; perennial irrigation now permits two or three harvests where the old basin system gave only one; without doubt improvement of the breeding of plants and animals, better agricultural methods, and higher prices have increased both gross and net production. Yet the standard of living of the *fellahin* still remains extraordinarily low and in many cases approaches destitution. The low scale of compensation for human labor in this country can be realized from a simple comparison of figures: the agricultural laborer working with his hands receives 5 to 6 piastres (25 to 30 cents) a day and the same man with a camel, 25 piastres.

Furthermore, the good lands in the delta are valued at £E250 the *feddan*, or about $1250 an acre; water, however, being included in this price. The *fellah*, in spite of his attachment to the soil, can acquire only extremely small parcels of land. In 1922, of the 1,923,000 Egyptian landed proprietors, 1,255,000 possessed less than a *feddan*.

Purpose of the Geographical Congress

It may be observed that the meeting at Cairo is in some respects a landmark in the history of Geographical Congresses. It is the first Congress held under the auspices of the International Geographical Union, constituted in 1922 and conforming to the International Research Council.[9] Now the statutes of the Union declare that one of its objects is "to organize international congresses and committees of such congresses." In April 15, 1924, the Union decided that Congresses include (1) meetings for the discussion of general questions; (2) meetings for the discussion of local questions of special interest to the organizing country; (3) geographical excursions.

The experience gained in Cairo well demonstrates the wisdom of this program. International Congresses are not intended to supplement the academies, societies, conferences, and publications of all sorts that have as their objective the diffusion of knowledge. The prime objects are:

(1) The discussion and adoption of certain arrangements necessary for

[9] See Union Géographique Internationale (International Geographical Union): Report for the period July, 1922, to December, 1924, with Lists of the National Committees and the Statutes, etc., edited by Sir Charles Close, General Secretary, 64 pp.; 1925. (In French and English.) Cf. *Geogr. Journ.*, Vol. 60, 1922, pp. 291–294; *Ann. de Géogr.*, Vol. 31, 1922, pp. 516–517, and Vol. 33, 1924, pp. 496–497. The Union up to the present is open only to allied or neutral nations. It includes the following countries: Belgium, Czechoslovakia, Egypt, France, Great Britain, Holland, Italy, Japan, Morocco, Poland, Portugal, Kingdom of the Serbs, Croats, Slovenes, South Africa, Spain.

international enterprises, such as the International Millionth Map of the World.

(2) The study of a limited number of questions of general interest whose advancement depends on international collaboration. These questions should be resolved long in advance; the work done thereon should be transmitted early so that a résumé may be available as a preliminary report before the meeting of the Congress; the discussion thus prepared should be full enough so that all interesting points can be developed; and finally the result of the work should be made the subject of a provisory or a definitive report. From this point of view it is gratifying to note that the Cairo Congress adopted the resolution proposed by Albert Demangeon, that "the program of the next Congress . . . shall include the question of the geography of the rural habitation and that a commission shall be constituted to establish a questionnaire and to centralize and coördinate the replies received."

(3) Finally it appears evident that one of the chief aims of every Geographical Congress should be to make better known the geography of the country in which it is held. It would be well to imitate the procedure of Geological Congresses and prepare the ground beforehand by lectures and by special publications, particularly guidebooks. All the excursions should be under the direction of competent guides and be accompanied by discussions on the ground. This presupposes that the groups should be relatively small; perhaps it would be necessary to divide each group into sections working simultaneously or successively.

By decision of the General Assembly of the Geographical Union, April 15, 1924, the next International Congress will be held in London in 1928. It may be hoped that the work of reorganization so happily begun at Cairo will be energetically continued.

AMERICAN GEOGRAPHICAL SOCIETY

Meetings of March and April and Elections to Fellowship. Regular monthly meetings of the Society were held on March 24 and April 21 respectively at the Engineering Societies' Building, 29 West Thirty-ninth Street. At the March meeting there was exhibited "The Epic of Mt. Everest." This cinematograph record of the Mt. Everest Expedition of 1924 was generously placed at the disposal of the Society by the British managers. President Finley gave a brief introduction with map slides showing the route of the expedition through Tibet and the immediate vicinity of the mountain with climbing routes and camps. Points of special interest in the film were: the marvelous ice scenery in the East Rongbuk glacier; the effects of cloud shadow and sunset upon rock and ice pinnacles; the climbing parties in all stages of the ascent; and the glory of the final pyramid, still unscaled.

At the April meeting the Society was addressed by Mr. Archer Butler Hulbert on "The Oregon Trail." Mr. Hulbert has for several years been engaged in the making of a map of the great overland trails of the United States. His experience during the past two years on the Oregon Trail and its place in our national history were the theme of the lecture.

At the March and April meetings, President Finley presiding, there were presented with the approval of the Council the names of 84 candidates who were duly elected as Fellows of the Society.

Presentation of the Charles P. Daly Medal to Dr. Knud Rasmussen. The presentation of the Charles P. Daly Medal of the American Geographical Society to Dr. Knud Rasmussen (see *Geogr. Rev.*, January, 1925, p. 130) took place at the American Legation at Copenhagen on March 9 last.

The gathering was honored by the attendance of H. R. H. Prince Gustav, brother of the King; H. S. H. Prince Christian of Schaumburg-Lippe; H. H. the Princess Viggo. The Prime Minister and Mrs. Stauning were present and members of the governmental and diplomatic services and scientific circles, including the President and officials of the Royal Danish Geographical Society.

The proceedings were opened by a brief address (in Danish) by the American Minister, Dr. John Dyneley Prince, who, after dwelling upon the distinguished services of Dr. Knud Rasmussen both to geographical and ethnological science, spoke of the history, interests, and functions of the American Geographical Society and particularly the significance of the Charles P. Daly Medal, reading to the assembly the list of the previous recipients of this honor. After bidding Dr. Rasmussen heartily welcome, the Minister then turned to the four Eskimo members of the Fifth Thule Expedition who were present and, addressing them in the Greenland Eskimo language, welcomed them to the Legation on this occasion, both as companions of Dr. Rasmussen in his recent researches and also as companions of Peary on his polar expedition. The Minister thanked Dr. Rasmussen for his words of praise, uttered in two public addresses in Copenhagen, of the United States Government's efforts in Alaska to better the condition of the Eskimo people in that territory and to further their future development. The Minister then presented the Medal to Dr. Rasmussen, wishing him every success in his future work.

Dr. Rasmussen replied in English, stating that inasmuch as the Minister, in compliment to Denmark, had made use of the Danish and Eskimo languages in his address of presentation, it behooved the recipient of the honor out of compliment to the United States to reply in the language of that great country. Dr. Rasmussen pointed out that American and Danish Arctic research have always moved side by side and with the friendliest coöperation. The Danes, he said, have

learned much from such American works as Nelson's "Eskimos of Bering Strait"; Murdock's "Point Barrow Eskimo"; and Franz Boas's work on the central Eskimos, especially those of Baffin Land. Of the American explorers who have visited Greenland, Dr. Rasmussen mentioned Hall, who began his work in the same Hudson Bay regions as Rasmussen had explored and ended his labors with his famous polar expedition in which he sacrificed his life. He alluded also to Kane, who for several years wintered in northern Greenland, and finally and especially to Robert E. Peary, the first man who had lived among the Eskimos as an Eskimo and had carried on all his explorations on the basis of the Eskimo traveling technique. This American-Danish connection, Dr. Rasmussen stated, he had particularly noticed at the close of his last expedition while in the United States, where he was most warmly received by American scientific men. With respect to the American Geographical Society, Dr. Rasmussen said that he had had the pleasure of being one of its Corresponding Members for some years and spoke of his cordial reception by the Society on his arrival in New York after the Fifth Thule Expedition.

Dr. Rasmussen stated that he was proud to accept the Daly Medal on the understanding that he was doing so not only on his own behalf but also on behalf of his Committee and of his staunch and brave comrades, both Danes and Eskimos, who had accompanied him on this last expedition and made its success possible. He emphasized the point that the award, therefore, was not for himself alone and added the words "not what I have, but what I do is my kingdom."

Dr. Rasmussen concluded his address by asking the assembly to rise and give three cheers for the United States, a request which was at once complied with by three sharp Danish rahs.

The Eskimos present thanked the Minister for his few words in Eskimo, which they stated they had understood perfectly.

Mr. Platt's South American Mission. Mr. Raye R. Platt, of the Society's Department of Hispanic-American Research, returned in April after a journey of eight months in Chile, the Argentine Republic, Uruguay, Bolivia, Peru, Ecuador, Colombia, and Venezuela. His mission to South America was for the purpose of visiting the various geographical and engineering societies, government bureaus, and other centers of geographical research and of studying the present status of geographical knowledge and tendencies in the field of geography, especially topographic surveys and map production.

Everywhere Mr. Platt was most cordially received and was given all possible coöperation in the accomplishment of his mission by government bureaus, scientific institutions, and individuals. He was able to add to the Society's collection of original and unpublished topographic field sheets, reduced airplane surveys based on photography, plans, profiles, and many other sources of cartographic and general geographic data.

Recent Publications

Bering's Voyages: Vol. 2. Steller's Journal of His Sea Voyage from Kamchatka to America on the Second Expedition. The second volume of Bering's voyages, *American Geographical Society Research Series No. 2*, is now ready for distribution. This volume contains the first translation in English of the account of the sea voyage on the second expedition, published in German in 1793 by the naturalist Georg Wilhelm Steller who accompanied Bering in the *St. Peter*. Steller's account is the most interesting of all the expedition's papers that have come down to us. The naval officers' log books and journals published in Volume 1 give the facts of the voyage: Steller's narrative with its caustic comment is primarily a human story. It contains

for instance one of the few accounts by an eyewitness of Bering's tragic end on a desolate island within two days' sail of the home port.

The two records supplement each other, sometimes even in matters of navigation, and that is one reason why they are published together. There are other reasons. Steller was the first trained naturalist in the North Pacific and he had opportunities for observation that were denied his successors. He was the only scientific observer of the sea cow, now extinct, that bears his name. He studied the habits of the blue fox and the sea otter before they were frightened away by man. In all that relates to these animals as well as on other phases of natural history which he records he speaks with authority.

In this volume Dr. Golder has had the coöperation of Dr. Leonhard Stejneger of the U. S. National Museum. Dr. Stejneger's translation has been used, and he has also contributed the footnotes to the botanical and zoölogical references in the journal, matter that he was peculiarly qualified to discuss by reason of his repeated visits in the North Pacific region where he has gone over the same ground as did Steller.

GEOGRAPHICAL RECORD

NORTH AMERICA

The Food Supply of New England. With respect to food supply the United States has reached a very pronounced turn in the road. If we count not only the cities of more than 2500 inhabitants but also those towns and villages of less population we find that by 1920, when the last census was taken, 61 per cent of the total population was urban and 39 per cent lived in purely country districts. While the increase in the total population from 1910 to 1920 had been 15 per cent, the increase in the number of persons living in towns and villages of less than 2500 was 21½ per cent. By contrast the absolute number of persons living in strictly rural districts had decreased by 227,000. When to this fact we couple the equally striking figures of relatively lessening exports of food supplies and a pronounced advance in the cost of foodstuffs of practically all varieties, we see of what immense importance to the future of the United States and the American standard of living is the question of the more efficient production of food upon our arable lands.

In New England the percentage of land in farms is 43, but only 36 per cent is used for the production of food crops and the like. The gravity of land conditions deepens when we look at population. Greater Boston, the region within say twelve miles of the State House, has a population of 1,500,000. If we increase the radius to fifty miles we include 3,000,000; and if we increase it to three hundred miles we include 23,000,000 people, or one-fifth the total population of the United States. Food consumers are increasing, food producers diminishing, and the acreage devoted to food production has markedly diminished. As compared with forty years ago, New England has seven million fewer acres of food-producing land and nearly three and one-half million more inhabitants to feed. Thus, in common with the rest of the country, a gradual transformation has taken place that calls for fresh study and continuing and even accelerated adaptations. But for an excellent educational system, cheap sea food, a considerable amount of water power, and certain advantages of position, New England would today live under paralyzing handicaps. For example, the number of spindles in the cotton factories of New England has increased 45 per cent in the last ten years, while in the South the number has increased 345 per cent. In 1920 New England spent about eight hundred million dollars outside her own territory to buy food, having consumed over a billion dollars' worth in all. That which is produced is grown upon a soil disposed in small lots that prevents the use of labor-saving machinery and an economic method of transportation and marketing. On the whole her production has been of a small-scale type developed upon a relatively infertile and patchy soil. To improve the general situation there was called at Boston, in January, 1923, a New England Agricultural Conference attended by the governors of all the New England states and other persons interested in agriculture. There followed a formulation of a definite policy for dealing with the present difficult situation. In an extremely interesting book entitled "The Food Supply of New England," prepared under the auspices of the conference and edited by Arthur W. Gilbert, these and other facts are set forth and proposed remedies considered.

Land Waste in Michigan. The northern half of the southern peninsula of Michigan is a geographical laboratory of increasing interest to science. Though much of the land has been cultivated since the early settlement of the state, a vast acreage now lies unused for any purpose. Some townships have diminished in population

to the point where local government has been discontinued, railroad lines taken up, and taxes no longer paid. The basis of earlier prosperity—virgin stands of white pine—has gone, and ordinary agriculture under present conditions is a failure. A vast area of idle and cut-over land here forms a diminishing asset to the state. The soil is sandy and when cultivated quickly loses its natural fertility. From this point on, skillful management is necessary if farming is to be profitable. Here and there virgin sandy lands may offer an opportunity for farming under present economic conditions . . . "but the greater part will doubtless have to await a great increase in population and a change from present economic conditions before . . . its cultivation can become profitable." Such is the statement that we have in a report upon the "Sandy Soils of Southern Peninsula of Michigan" by M. M. McCool and J. O. Veatch (*Special Bulletin No. 128*, January 1924, of the Agricultural Experiment Station, Michigan Agricultural College). The report consists chiefly of a technical discussion of the soils: their physical and chemical nature and their classification. As a contribution to the formulation of definite plans of procedure for individual landowners it is a highly commendable piece of work. The illustrations exhibit a most interesting variety of agricultural conditions that now obtain on these sandy soils. Climatic and special conditions have much to do with their use: a warm climate, as on the leeward side of Lake Michigan, and a situation close to markets resulting in improved technical processes and a relatively high grade of agriculture. The authors recommend that the cut-over, unimproved lands of Michigan and other states, amounting in all to two hundred million acres in the whole country, should be studied from the standpoint of tree crops and forestry rather than for agriculture alone under present economic conditions and density of population. The accompanying map (Fig. 1) shows where forestation projects are likely to be most feasible from the standpoint of soils. Though the shaded area represents chiefly sandy soils, some bodies of clay land are also included.

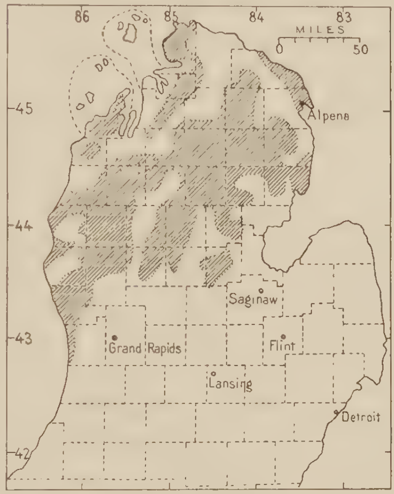

FIG. 1—The southern peninsula of Michigan. Shading shows the area where forestation projects appear most feasible from the standpoint of soils.

Geographical and Hydrographical Reconnaissance of the San Juan Canyon. Pawhuska, the Navajos call it, "mad water," an appropriate name for the San Juan in its canyon course from Chinle Creek to the Colorado River, 63 miles by air line, 133 by stream. Mr. H. D. Miser followed its course with a U. S. Geological Survey party in 1921, believed to be the fourth party to descend the canyon in its entirety, and describes the results in *Water-Supply Paper 538*, 1924. The work was part of a scheme for mapping and study of proposed power and storage projects along the Colorado and its tributaries (see articles in the *Geographical Review*, "The Rainbow Bridge, Utah," Vol 13, 1923, pp. 518–531, and "A Boat Voyage Through the Grand Canyon of the Colorado," Vol. 14, 1924, pp. 177–196).

In the greater part of its canyon course the river is deeply entrenched; at Cedar Point, for instance, the canyon walls are 2000 feet deep. The general width of the channel is 150–200 feet; it is only 50 feet at the narrowest, 3300 at the widest, at Piute Farms where the valley is broad and terraced. Rapids are not of large size

but are numerous; the average fall is seven feet to the mile. Muddiness of the waters, quicksands, frequent and sudden rises of the stream are characteristic. In the narrower parts of the canyon, flood stages reach as high as 50 feet. In July, 1904, the river had a minimum discharge of 20 second-feet; in October a maximum of 20,000. In 1905 it had a January minimum of 40 second-feet, and in June a maximum of 24,800. The amount of silt carried is unusually high for streams in the United States. Except during great floods the river runs over fill for the greater part.

The surface of the river water is mostly rough. Besides the waves produced by the rapids, are waves characteristic of streams carrying a heavy load of débris. During flood stages at Piute Farms, where the channel is wide and shallow, the current was observed to flow in surges about a foot high, each preceded by a ragged splashing wave as much as six feet high. The phenomenon known as "sand waves" was also conspicuous during flood stages; these waves would start at the downstream end of a stretch of swift water and travel upward attaining heights of six or seven feet.

The region in which the canyon lies is marked by its inaccessibility and desertic character. An area 50 miles square north of the San Juan and east of the Colorado River is uninhabited, visited only by herdsmen in the winter. The Survey party spent two and a half months in the canyon, frequently making trips of six or seven miles or more from the river. Between the villages of Goodridge and Medicine Hat at the beginning of the canyon, which have a combined population of half a dozen persons, and Lees Ferry on the Colorado they met no white men and only three Indians. In the canyon traces of temporary occupation are to be seen, but the number of cliff dwellings was found to be "surprisingly small." The rainfall of the canyon and its immediate surroundings is estimated at five inches or less; grass is scant and the amount of tillable land very meager. At Piute Farms, where land has been under cultivation in recent years, it amounted only to a few acres.

City Growth in the Kentucky Mountains. The 1920 census of the United States showed over 50 per cent of the population dwelling under urban conditions, i. e. in incorporated places of 2500 and over (61 per cent if we include all towns and villages). In the Kentucky mountains the urban population was only seven per cent of the total. Small as the figure is it represents a development of the last two decades, as Mr. D. H. Davis shows in the volume "The Geography of the Mountains of Eastern Kentucky" (*Kentucky Geol. Survey*, Ser. 6, Vol. 18, Frankfort, 1924). Prior to 1900 pioneer conditions existed all through that isolated region of our "contemporary ancestors." Through the previous century population growth had been steady, but it was dominantly agricultural and increase almost entirely genetic. In 1800 Prestonburg with a population of six was the only mountain settlement mentioned in the U. S. Census section on "Towns and Cities." In 1810 Prestonburg and Barbourville with populations of 32 and 55 respectively were the largest settlements. By the mid-century the population density for the mountains as a whole was between 6 and 18 per square mile with greater density in the lower Big and Little Sandy basins. Progress in the former has been recently described by the State Geologist, W. R. Jillson (The Big Sandy Valley: A Regional History Prior to the Year 1850, Louisville, 1923). As late as 1870 the only places with population over 1000 were Ashland and Catlettsburg, which are, however, marginal to the mountains proper. By 1900 density had risen from 18 to 45 per square mile with higher figures in the coal-mining areas of the Upper Cumberland and Big Sandy basins. Ashland, Catlettsburg, and Middlesboro had risen to over 2500. At the last census eight places had passed the 2500 limit. Of 36 towns with over 500 population 15 had not even been listed in 1900.

This movement towards urbanization is primarily dependent upon coal mining (on growth of the industry see W. R. Jillson: The Coal Industry in Kentucky,

2nd edit., *Kentucky Geol. Survey*, Ser. 6, Vol. 20, Frankfort, 1924), with improved transporation as an accessory factor. An example is Hazard, numbering less than 100 people in 1890 and over 4000 in 1920. Harlan had 557 in 1900 and 2647 in 1920. Some mining camps have expanded to city size with the economic life of the community centered round the activities of a single great mining company: such is Jenkins (4707) ranking fifth in population. Other towns more normal in growth engage also in small manufactures, making use of local resources. Ashland (14,729) and Catlettsburg (4183), separate municipalities but essentially one community, together form the largest agglomeration in the mountain counties. Situated on the river terraces of the Ohio, with some benefit gained from river traffic but far more from the convergence of land ways, the agglomeration is dependent on a much wider area than the mountains. The largest center of the mountains proper is Middlesboro (8041), strategically situated with regard to the Cumberland Gap.

In the eastern two-thirds of the mountains, the country of the "creek bottom settlements," most of the towns are situated on the major drainage lines (an excellent illustration of the creek bottom settlement is afforded by the Harlan quadrangle of the United States Geological Survey). Many are of a linear pattern in adjustment with the topography. In the western third of the mountains, where the valleys are still steeper and narrower and the interfluvial spaces afford more level ground, the ridge top settlements are less restricted both as to location and plan. The railroad has often been a determining factor here; such is the case of Corbin (3406). Few towns are of the characteristic southern type, built round the courthouse square. Pineville (2908), however, is an exception.

The present urban movement is likely to continue. Probably it will result in the formation of a relatively large number of comparatively small centers rather than a few major foci.

SOUTH AMERICA

Recent Exploration of the Laguna Iberá, Argentine Republic. The Laguna Iberá is a broad and somewhat inaccessible tract of swamps and lakes in the heart of the Argentine Mesopotamia (province of Corrientes). Said to be one of the least-known parts of the Argentine Republic, doubt and misconception have hitherto prevailed regarding its topography and physical geography, and popular legends have grown up of "strange and terrifying voices" rising from its vegetation-choked waters. The region has recently been visited by Gaetano Rovereto, who describes his exploration in *L'Universo* for January, 1925 (Vol. 6, pp. 3–23).

The Laguna Iberá occupies a shallow basin along the contact between a formation of Mesozoic sandstones and basalts which have been worn down to an almost level peneplain to the east and south, and a formation of Pliocene fluvial siliceous sands and semi-consolidated gravels to the north and west. As is true of similar basins in the peneplain to the east, Rovereto attributes the origin of the Iberá basin to eolian excavation during a period geologically recent when the climate was drier than it now is.

The *laguna* is one of the rare examples of a lake with more than one outlet. Through two broad "furrows" or depressions its waters make their way southward across the peneplain to the Rio Corrientes which flows into the Paraná and to the Rio Miriñay, a tributary of the Uruguay. At high water the *laguna* also finds other outlets, notably one northward into the Paraná at Ituzaingo. There are no outlets to the east where the western rim of the peneplain is comparatively high.

The most extraordinary feature of the Laguna Iberá itself is the *embalsado*, which resembles the sudd of the Upper Nile. These masses of floating aquatic vegetation cover about two-thirds of the surface of the *laguna* leaving only about one-third as open water. Channels which, curiously enough, are but rarely obstructed, run

through the *embalsado* rendering possible navigation in small boats. In general there is clear water where the depth is over three meters. Except at the outlet into the Rio Corrientes, Rovereto observed but slight signs of soil formation or of the accumulation of deposits of peat.

Inasmuch as the Laguna Iberá has no direct surface connection with the Upper Paraná, from which it is separated by a low ridge, there has been some difference of opinion in regard to the origin of its waters. Of three theories which have been adduced to explain this—rising to the surface of subterranean waters, infiltration from the Paraná, and rainfall—Rovereto shows the first two are untenable. The Laguna Iberá lies in a zone in which the mean annual precipitation is between 47 and 55 inches, a rainfall which would seem to be sufficient to account for a permanent supply of fresh water.

From the economic point of view, the extreme flatness of the ground gives little prospect that the Laguna Iberá may be utilized effectively for water-power purposes or for the regulation of navigation on the Paraná and Uruguay Rivers without excessively costly operations. The northern part of the area may be partially drained by deepening the outlet of Ituzaingo. "A great part of the *laguna* may be made navigable by opening canals in the *embalsado;* communications may be established with the Paraná, by regulating the outlet into the Rio Corrientes and the upper course of that stream, which is now navigable along its lower course."

EUROPE

Italian Immigration to France. "One of the most striking facts of French demography is the increasing number of strangers since the middle of the nineteenth century" says M. Zimmermann in his analysis of the 1921 census (Maurice Zimmermann: La population de la France en 1921, *Ann. de Géogr.*, Vol. 31, 1922, pp. 37–51). Foreigners numbered 5 per cent at this census as against 1 per cent in 1851. They have compensated in some measure for the continuing decline of native increase. Of recent years the most significant feature of this phase of the population movement has been the growth in the number of Italians. They are now in the lead, having quadrupled since 1872 when the Belgians were three times as numerous. Italian immigration to France is, however, no new thing. Italian models were to be found in France in the seventeenth century; other interesting nomad types followed —the chimney sweeps and bootblacks and glaziers of Piedmont, the statuette makers of Lucca, the itinerant musicians (see a picturesque work "Larmes et sourires de l'émigration italienne," by R. Paolucci de' Calboli, Paris, 1909). The decline of rural population commencing in the middle of last century was partly met by Italian immigration; and so the later demand for workers in the Briey mines. The immigration has been largely from northern Italy and has been seasonal in character as is the "golondrina" movement to Argentina (on the general subject of Italian emigration see the excellent work "The Italian Emigration of Our Times" (*Harvard Economic Studies*, Vol. 20), by Robert F. Foerster, Cambridge, Mass., 1919).

Since the beginning of 1923 a new phase may be discerned (Emigration of Italy's Rural Population to France, *Econ. Rev.*, April 17, 1925, pp. 346–347). Figures are eloquent. They are from the official *Bollettino della Emigrazione* (a different system of record was in operation between 1921 and 1923 and 1924, but the results are sufficiently comparable). In 1921 the oversea movement numbered 194,320, of whom 137,617 had the United States for destination; continental emigration numbered 60,846, of whom 36,179 went to France. In 1923 the oversea figure was 177,853 (57,686 to the United States), the continental figure 170,226, of whom 142,990 went to France. For 1924 the respective figures were 130,779 and 201,591, with 173,664 to France. The French immigration is chiefly directed to the southwestern corner of the country where depopulation has been marked, notably in the basin of Aquitaine

where "it is an evil of long standing and extends over a large area. There are four departments in particular where withdrawal of population is felt." Between 1911 and 1921 Lot lost 14 per cent of its population, Gers 14.9, Tarn-et-Garonne 11.6, Lot-et-Garonne 9.2. Since 1872 the decline in these departments ranges from 37 to 25 per cent. It is stated that in the Agen district (Lot-et-Garonne) there is one Italian to every five French peasants and in the Toulouse district one to every ten.

The character of the immigration also has changed: whole families come, and they come to stay; and this means that their capital is retained in the country. The price of land naturally is rising; but it is still lower than in Italy, and the standard of living is superior. The immigrants usually become semi-leaseholders. They are generally well received for their technical ability and social qualities. Among particular expectations from their presence are hopes for the revival of silk cultivation by the settlers from Lombardy and Venetia.

AFRICA

The Prediction of Ocean Swells Along the Moroccan Coast. The coast of Morocco facing the Atlantic Ocean is remarkable for its regularity of outline. Stretching some five hundred miles southwestward from the Strait of Gibraltar the coast line shows not a single noteworthy gulf or estuary, and even the capes are few and generally not well marked. The commercial activity of the ports on this stretch of coast is therefore dependent to a large extent on the condition of the sea and particularly on the state of the swell. The ocean swell which makes this coast inhospitable to shipping is felt even in the harbor of Casablanca, protected though it is by large jetties. These swells at times assume such proportions as to cut off communication with the land and seriously damage vessels alongside the wharves and even those at anchor. On January 8,1913, a series of large swells paralyzed the commerce of the port of Casablanca for several months by destroying seven ships and nine laden barges, besides damaging thirteen other barges.

The French naval authorities charged with the task of maintaining communication with the Moroccan Protectorate have given the matter serious consideration, and, after a series of investigations beginning in 1907 but interrupted by the war, a service for the prediction of swells was organized at Rabat on July 1, 1921, by the Department of Public Works of the Moroccan Protectorate. The work of this service is described by Lieutenant Montagne (R. Montagne: Le service de la prédiction de la houle au Maroc, *Annales Hydrogr.*, Ser. 3, Vol. 5, 1922, pp. 157–184). Every day at 8:30 A. M. a telegraphic message is sent to all the Moroccan ports and is also broadcast by wireless, giving the condition of the sea as observed at 7 o'clock and predicting its state for that and the following day.

Lieutenant Montagne summarizes the studies on which these predictions are based. It was found that the occurrence of swells on the Moroccan coast could be correlated with the track of barometric depressions across the Atlantic. At Casablanca, for example, analysis proved that the swell was in the majority of cases brought about by a depression between the Azores and Iceland. Various modifying conditions have been discovered for each port, but, contrary to what might have been expected, local meteorological conditions are factors of only slight influence. At the present time the predictions appear to be 70 per cent correct. That is, seven out of ten times the predicted swells materialize. The swells which arrive unheralded do not constitute as much as 20 per cent of the observed swells, and, fortunately, these are generally not the dangerous swells. It is hoped, however, by further study to reduce the percentage of unpredicted swells to no more than five per cent. The predictions have proved of value not only in shipping but also in harbor improvement and marine construction.

H. A. Marmer

The Human Geography of Africa Before European Colonization. Seventeen years ago Professor Siegfried Passarge contributed to *Petermanns Mitteilungen* (Vol. 54, 1908, pp. 147–160 and 182–188) an important article on the natural regions of Africa. This article closed with a short section on human geography, which has now been supplemented by the same author in a suggestive paper entitled "The Political Geography of Africa Before the Intervention of European Colonization" (*Petermanns Mitt.*, Vol. 70, 1924, pp. 253–261). Illustrated by five maps, this paper brings out clearly the mutual relations between the natural regions of the continent and the distribution of races, political organizations, and social and economic practices.

Passarge's map of the natural regions of Africa shows four concentric zones (*Landschaftsgürtel*) surrounding the "rain-forest region" of the Congo basin and Cameroons. Immediately enclosing the rain forests, except where they abut on the sea, are "moist-steppe regions" (*Feuchtsteppenländer; Galeriewaldsteppen* on map); these in turn are surrounded by regions of "dry steppes," including much of the Sudan, the African lakes, Rhodesia, and Angola, and running south along the east coast as far as Cape Colony, with an isolated tract lying east of the upper Nile. The "dry-steppe" zone as a whole merges on the north and on the southwest into vast "dry regions" which Passarge subdivides into deserts and "salt steppes" of various types. The Mediterranean fringes of Morocco, Algeria, Tunis, and Cyrenaica, as well as the southern tip of Cape Colony, are a zone of sclerophyllous vegetation (*Hartlaubländer;* woodland and forest).

The distribution of the present native population and of political, economic, and social institutions in the Africa of pre-colonization days bears a close relation to these zones. For instance, the map showing the former political geography of the continent reveals, besides the territories under Turkish domination in the north, two more or less concentric belts formerly made up of native states of no little power and complexity of organization. The inner belt, including among others such negro political associations as those of Ashanti and Dahomey in the west and of Uganda, Ruanda, and Katanga in Central Africa, corresponds to the "moist steppes." The outer belt, comprising the Moslem sultanates of the Sudan and, in East and South Africa, the sultanate of Zanzibar, the "great feudal states of the Zulus and Bechuanas," as well as the kingdom of Monomotapa in Matabeleland, corresponds with the zone of "dry steppes" and with certain favored rugged tracts like Darfur and Kordofan in the adjacent zone of "salt steppes." A similar concentric arrangement of economic and social institutions may be discerned. Thus a vast region where agriculture alone predominates centers in the Congo basin and is surrounded to the north, east, and south by regions where agriculture and pasturage prevail together; these regions in turn adjoin drier tracts where the essential industry, other than the agriculture of the oases, is stock raising.

The most original part of Passarge's paper is a hardy attempt to explain the historical origins of racial characteristics and customs in certain parts of Africa where these characteristics and customs differ widely from those which may be regarded as indigenously African. The extraneous cultural and racial conditions Passarge believes to be due to tribal migrations and cultural influences radiating from southeastern Asia. The latter he calls a *Stossherz* ("heart of out-thrust"), meaning a region inhabited by exceptionally virile stocks which have tended to burst forth from time to time over the neighboring countries in waves of migration or of conquest. At an early period Egypt constituted a barrier of typically African civilization which prevented the influences of the Asiatic *Stossherz* from penetrating into North Africa; but the Egyptian dam was ultimately destined to give way, admitting the sweep of Asiatic conquest and civilization through the whole stretch of the Sahara and through the Sudan to the very borders of the tropical rain forests and to the swamps of the upper Nile valley. Before the breaking of the Egyptian dam,

however, Passarge suggests that a "flood of nomadic shepherds" had crossed from southern Arabia into Africa. "It would be conceivable that this stream of cattle herdsmen . . . was so overwhelming that not only the arid tracts and steppes of northeastern Africa but also the long reach constituting the dry steppes of East Africa were occupied and the negroes shoved aside into the isolated mountains on the highlands, into the East African cul-de-sac (that is the coastal zone between Mombasa and Delagoa Bay where cattle raising is not possible), and into the Congo Basin." This hypothetical influx of Hamitic tribes would, then, help explain two of the long-standing mysteries of African origins. The Hottentots would represent a mingling of indigenous Bushmen with the incoming Hamites. The wide and uniform extent of the Bantu speech over the greater part of Central and Southern Africa as contrasted with the diversity of languages among the negroes of the Sudan would be due to the combination of Hamitic invaders with negroes. The mixed folk thus produced would bring together "the energy of the pastoral tribes with the agricultural skill and the craftiness of the negroes," and these qualities joined "with superior organization and superior armament," would render possible the rapid spread of a uniform and dominant language.

The Economic Geography of Katanga. An interesting and difficult problem in economic geography and colonial administration is presented in the relation of the Belgian Congo as a whole and more especially of its southeastern part, Katanga, to the neighboring colonies of other nations. Professor Robert of the Free University of Brussels, Director of the Geographical and Geological Service of Katanga, has shown clearly that the Belgian colony is a unit neither from the physiographic nor from the economic point of view (Maurice Robert: Le Congo physique, Brussels, 1923, pp. 293–309). The broad, central basin with its tropical rain forests and great rivers, though ultimately destined to yield immense riches, is unsuited to permanent white settlement and should be regarded essentially as a *colonie d'exploitation*. On the other hand, the plateaus and highlands enclosing the basin to the south and east favor white colonization; and in Upper Katanga notable mineral resources have already stimulated an industrial development that seems strangely out of place in the heart of Africa but gives promise of future prosperity. The problem lies in the fact that these peripheral regions do not find their normal outlets upon the world through Belgian territory and that they are subjected to economic influences radiating from neighboring lands under alien flags.

Much of the eastern part of the Belgian Congo, including Lower Katanga, lies in the hinterland of Dar es Salaam: a railway connecting the Lualaba with Albertville on the western shore of Lake Tanganyika, steamers on the lake, and another railway running through Tanganyika Territory to Dar es Salaam combine to make a far easier line of communication than does the devious "Transcongolais" route to Boma with the seven transshipments from rail to water and vice versa which the latter route necessitates.

Upper Katanga, extending as a long peninsula far into the heart of Northern Rhodesia, has been connected since 1910 with the South African railway system. It is even more true of this southeastern corner of the Belgian Congo than of the eastern fringes, that it lies remote from Boma and in the sphere of economic influences coming from without. The copper mines of Katanga, which have long been known to the natives though native exploitation of them probably ceased at least a century ago (F. Ladame, Le droit des indigènes sur les mines de cuivre du Katanga, *Congo*, Vol. 2, 1921, pp. 685–691; reference on p. 687), have given rise within the last decade to what is by far the most important metallurgical industry in the Belgian Congo and one of the most important in the whole of Africa. Dr. Walther Kühn, writing in the *Zeitschrift für Geopolitik* (Vol. 1, 1924, pp. 775–780), shows that the percentage of metal in the ore is remarkably high, running from 6 to

8, while the highest percentage in American mines is only 5; open mines or copper quarries may be operated, whereas elsewhere the ore must be extracted from great depths; and since 1919 coal for smelting purposes has been readily derived from points near at hand in Katanga itself. These circumstances have enabled the local industry in Katanga to withstand the general depression that affected the copper industry of the world at large after the overproduction of the war period. Indeed, in 1922, no less than 6 per cent to 7 per cent of the world's total output came from this remote colony. Kühn asserts that, though politically Katanga may be Belgian, it should be shown on an economic map as lying within the South African sphere of influence. Its lines of communication with the outside world run to the south, not north; its broad plateaus are separated from those of Rhodesia by a political boundary only; its vegetation is the open, dry-forest type of Rhodesia rather than the tropical rain forest of the Congo basin; its climate is more like that of South than of Central Africa (see the useful little volume by A. de Bauw, Le Katanga: Notes sur le pays, ses ressources et l'avenir de la colonisation belge, Brussels, 1920, pp. 6–8). British economic penetration has already gone far. In the concluding sentences of the volume to which we have referred, Professor Robert warns his compatriots that there is only one method by which they can prevent Katanga and the region south of the Kasai from falling definitively into the zone of influence of foreign colonists. This is by more actively interesting themselves in the development (*mise en valeur*) of these districts than they have done in the past. Professor Ernest Dubois, in a preface which he contributes to De Bauw's volume cited above, points out that of a total of 6266 Europeans in the Belgian Congo in 1918 only 3263 were Belgians and of these 3263, 2438 were officials. In 1920 the white population of Katanga was 3088, of which 1621 were Belgians.

ASIA

The Population Problem in India. The Census of India has a unique value in the variety and authenticity of information it affords for a great area in the tropics. This is impressively shown in two papers by Mr. J. T. Marten, Commissioner of the Census, read before the Royal Society of Arts. The earlier paper, published in the Society's *Journal*, April 6, 1923, outlines the methods and results of the 1921 census; the later paper, in the March 20, 1925, number of the *Journal*, discusses population problems from the census.

The population of India as a whole is self-contained. Growth is by excess of the high birth rate over the high death rate and for the census period (the first census was taken in 1872) shows great decennial fluctuations. Percentage gain by decade has been thus: 1881–1890, 9.5; 1891–1900, 1.5; 1901–1910, 7.1; 1911–1920, 1.2. The 1891–1900 decade shows the effect of catastrophic years of famine (cf. Paul Vidal de la Blache: Le peuple de l'Inde, *Ann. de Géogr.*, Vol. 15, 1906, pp. 353–375 and 419–442, especially Fig. 5, p. 429). The small increase of the last decade is due to the influenza epidemic of 1918–1919. In 1918 the excess of deaths over births exceeded 27 per thousand: a conservative estimate places losses from the disease at 12,500,000. Moreover the effect on the age composition of the population is such that one may expect it to have a retarding effect on the population growth of the next decade. Such catastrophes apart Mr. Marten believes the rate of increase is influenced by direct effect of climate rather than by economic factors. "It is well known," he says, "that dry years are, on the whole, the healthiest, though they are not usually years of economic prosperity. On the one hand there appears to be an intimate connection between the quantity and distribution of the rainfall and the intensity of the infection of the diseases, such as malaria, dysentery and so forth which are chiefly responsible for the mortality."

However this may be, the actual increment of India's population has been over 50,000,000 in the last 50 years; and a "normal" increase in the next decade of eight per cent, if one can speak of such a thing, would mean an addition of another quarter million. Is the overpopulation problem imminent in India? Mr. Marten does not seem greatly apprehensive. There are some areas in the Ganges valley and eastern Bengal with a rural population of 1000 and even 1200 per square mile, but population density alone is not significant: pressure on subsistence can exist at any density; it is responsible to a large extent for the unrest in the tribal areas of the North-West Frontier where the average density is a "ridiculously low figure." Mr. Marten believes the land capable of greater productivity under more economic utilization and cites in illustration the Punjab where exists "an enormous margin for the development of agricultural wealth" apart from the extension of irrigation.

Local overpopulation is largely a want of adjustment. It is being increasingly relieved by migration within the country. In the last decade the completion of the great irrigation works on the Thelum and Chenab Rivers led to a considerable movement from the congested tracts in the northern and central Punjab to the southwest of the province. The undeveloped lands of Assam draw on eastern Bengal. The tea garden population is chiefly recruited from the lowest strata of the United Provinces, the Central Provinces, and Bihar and Orissa. The population of Assam has nearly doubled in the last half century; today nearly a quarter of it is of foreign extraction. Important streams of labor, partly agricultural, partly industrial, flow from the backward classes of the Madras Presidency to the plantations of Mysore and Travancore and overseas to the plantations and factories of Ceylon, the Malay States, and Burma. The number of Indians in Burma increased 16 per cent in the last decade. Labor emigration out of India has recently been checked by legislation, but it is estimated that there are one and three-quarter millions of Indians in other parts of the British Empire.

As agriculture proper still gives occupation to over 70 per cent of the population it is obvious that urbanization cannot have made great progress. As a matter of fact, urban increase in the last 30 years amounts only to one per cent. It is the large towns that have grown; medium-sized towns remain stationary or are decadent. Percentage increase is thus: towns over 50,000, 16; 20,000–50,000, 8; 10,000–20,000, 1.

AUSTRALASIA AND OCEANIA

Report on the Sir Edward Pellew Group of Islands. As is well known, the "Queensland route" is one of the alternative projects in the plan for a transcontinental railway to unite Northern Territory with southern Australia. In connection with the Darwin-Camooweal link of this route it has also been proposed to run a branch to the Sir Edward Pellew Islands of the Gulf of Carpentaria whereby a port would be provided for the pastoral lands of the Barkly Plateau region. The islands lie off the mouth of the McArthur River, up which at Borroloola is a cattle station. They are at present populated by a tribe of aborigines who wander from island to island, at times going as far as Borroloola, traveling in log canoes and living mainly on fish. The islands have been described in a recent Australian publication as "blessed by constant rainfall and greened with much vegetation." However not quite so attractive a picture is painted by Lieutenant Paradice in his recent report on the group (W. E. J. Paradice: The Sir Edward Pellew Group of Islands: Report with Special Reference to Biology and Physical Features, *Commonwealth of Australia Parliament 1923–24* [*Publ.*] *No. 143*, [Melbourne,] 1924.

Settlement would be handicapped by the barren nature of the soil. Tracts suitable for vegetable gardens are limited on the islands, and the salt flats of the mainland are even worse; such supplies, however, could be obtained from Borro-

loola in the advent of the railway. There is not sufficient grazing for sheep and cattle, but goats would probably thrive. Vanderlin has a large fresh-water lake, "of the utmost importance" but "easily missed"; and so Lieutenant Paradice gives careful instructions for finding it. An industrial water supply might be obtained by damming some of the valleys for storage of the waters of the rainy season. The winter climate is described as ideal. Daytime temperatures range from 75° F. to 80°; night temperatures from 68° to 75°. During the first half of the summer the temperatures were 5° higher. No experience was had of the midsummer wet season, but it is believed to be preferable to that of Darwin, Thursday Island, or similar latitudes on the Queensland coast.

Vanderlin, the chief island, 20 miles by 7, and other larger members of the group are built of ridges of hard sandstone which descend steeply to valleys whose level floors are composed of almost pure sand, swampy in the wet season, quite dry at the end of the dry season. The shores are lined with a coral conglomerate to an altitude of about 30 feet above high tide, indicative of uplift. Jensen has shown that such a movement commencing in early Tertiary time affected Northern Territory as a whole. On the flats are scattered palms and clumps of pandanus, acacias, and small eucalypts; at the foot of the hills are larger eucalypts and cypress that might afford a fairly useful timber; the southern beaches are mangrove-bordered.

The 1924 Eruption of Kilauea Volcano. The 1924 eruption of Kilauea Volcano closely fulfilled the seismological prediction of a 130-year cycle. In the *Monthly Bulletin of the Hawaiian Volcano Observatory* for May, 1924 (Honolulu), T. A. Jaggar quotes: "In considering the menace of volcanic disaster, common intervals between great crises are in multiples of 65 years. One hundred and thirty years is a common interval. 1920 will be 65 years since the tremendous activity of 1855 for both Kilauea and Mauna Loa, 1920 will be 130 years since Kilauea exploded." In November, 1919, and again in May, 1922, subsidence of lava in Halemaumau pit was phenomenally strong, the latter leading to enlargement of the pit, extraordinary avalanching of the sides producing "cauliflower clouds of sand and dirt." Parallel events, "harmonic tremor indicating underground lava surging, southerly tilting, numerous earthquakes . . . subsidence of the Halemaumau floor," led up to the outburst of 1924. A diary of happenings is given by T. A. Jaggar and R. H. Finch in "The Explosive Eruption of Kilauea in Hawaii, 1924" (*Amer. Journ. of Sci.*, November, 1924) and a summary by R. H. Finch in "Seismic Sequences of the Explosive Eruption of Kilauea in May, 1924" (*Bull. Seismol. Soc. of America*, December, 1924).

The Halemaumau pit, which is at the southwestern end of the broad sink forming the top of the Kilauea dome, varies in size with phases of activity. Prior to the 1924 eruption it measured 1500 feet across by 2000 feet. Towards the end of February the molten lava lake 105 feet below the rim disappeared from view, leaving a level floor at a depth of about 375 feet. Subsidence began at the end of April. On May 10–11 the explosive phase was entered upon, activity increasing on May 13. "There were two main explosions May 15, four on the 16th, five or six moderate explosions in the night May 16–17, three big ones and many small ones on the 17th, at least five heavy explosions on the 18th followed by a night of steam clouds and avalanches, eight moderate explosions on the 19th, and five smaller ones on the 20th." "Surf-like, roaring noise preceded explosions and diminished after them. Excessive tremor was recorded during the first few days only. Earthquakes were numerous. Heavy electrical storms accompanied by pisolitic mud rains followed the larger explosions. Brilliant lightnings shot through the cauliflower ash clouds. A marked air concussion was felt before the larger explosions."

Rock barrages thrown out at the period of maximum activity, May 18, reached as far as 4000 feet from the rim; one 8-ton boulder was flung 3500 feet. The whole

country was gritty with new-fallen ash of the May explosions. Dust was blown about in simoon whirls. Some clouds attained heights of over 15,000 feet. Dust that fell 1800 feet away was still hot enough to scorch vegetation. Apparently the eruption was smaller than that of 1790 which in turn was smaller than some of its predecessors. The total volume of ejecta did not greatly exceed 50,000,000 cubic feet of uncompacted material. At the Observatory, two miles to the northeast, the total fall of dust and lapilli was not much over one-half inch in thickness.

POLAR REGIONS

Arctic Ice as an Agent of Erosion and Transportation. E. M. Kindle has collated data on the work of ice in the North Polar regions as observed by various expeditions, especiallv the Canadian Arctic Expedition, 1913–1918 (*Amer. Journ. of Sci.*, April, 1924). Under the tundra climate with active erosion for two months or more during the year land degradation proceeds at a rapid rate. From the spring break-up the streams are active agents; frost penetration is deep, protective snow cover light. Mr. Stefansson says that three-quarters to nine-tenths of the surface of Arctic lands is nearly free from snow at all seasons. Strong offshore winds are common and carry sediment to the sea ice. Ground ice, which still remains more or less of a mystery, acts in a minor capacity through the undercutting of cliffs or banks in which it occurs.

Floe ice driven against the shore or scouring the sea bottom in shallow water is a powerful agent of erosion. "Scoresby has calculated that one of the immense ice fields which he mentions is capable of delivering a blow or shove equal to 10,000,000,000 tons. When it piles against a shore cliff 80 feet high, as a member of the *Karluk* crew reports, its efficiency in rock abrasion is evident." Land-fast ice lifted off the bottom in gales and the ice foot that forms along the shore between tide marks carry large amounts of land débris. Mr. Kindle quotes from the diary of F. Johansen who accompanied Mr. Stefansson on the Beaufort sea ice journey: "First some ice was screwed up close to the beach here and there; then came an immense and continuous pressing of the ice from far off-shore onto the beach. Like the movement of a glacier the whole body of sea ice moved eastwards; without regard for shallow water the coastal ice was pressed up on the beach and during this slow but continuous movement the ice ploughed down in the sand where this was the beach material and on the coast of tundra-bluffs the ice first shoved away the boulder gravel wall in front, tearing it up, going over it and raising often immense boulders and driftwood trunks on its 'back' after which it ploughed into the tundra-bluffs and overlapped these. The movement of the ice lasted for almost an hour and when it stopped the appearance of the coast was quite changed. Some parts of the higher tundra-bluffs had their seaward side covered by the coastal ice stretching to the upper margin of these and immense blocks of ice, boulders or tree trunks from the beach were raised and pushed still further in on the tundra."

Kane early called attention to the material carried by berg ice and the effect of grounded bergs as modifiers of the submarine topography. By reason of great bulk glacier, or snow-made, ice is a highly important agent of transportation, with floe ice being responsible for the wide distribution over the sea floor of the detritus of the circumpolar lands. Floe ice possesses a crystalline structure different from river and lake ice and disintegrates far less rapidly. In parts of the Arctic it probably survives many summers' heat and travels far from the place of origin. Paleocrystic ice, attaining great thickness through pressure and overthrusting, may be very ancient. From the evidence of the associated molluscs sedimentary material carried by the ice floes on the east coast of Greenland is believed to have been derived from Siberia. Caution must be used in making geomorphological deductions from the

character of the sea-floor deposits: the presence of shallow-water shells in deep water may be due to transportation and not indicative of subsidence.

Characteristics of Polar Climates as Revealed by the Yearly Temperature Curve. Within the last two decades or so there has been a very remarkable increase in our knowledge of polar meteorology; and, while it is clear that only the outlines of the climatic picture can yet be sketched in, any serious study of polar climates on the basis of the available data is most welcome. Such a study we have before us in Dr. Pollog's recent monograph (C. H. Pollog: Untersuchung von jährlichen Temperaturkurven zur Charakteristik und Definition des Polarklimas, *Mitt. Geogr. Gesell. in München*, Vol. 17, 1924, pp. 165-253).

Temperature is taken as the most critical and most serviceable basic climatic element in defining or characterizing polar climates as a whole. The controls over temperature by bare ground, water, snow, and ice are discussed, especially in the cases of the last two which, because of active and effective radiation, operate as chilling agencies. As the chilling takes place in the lower air, inversions of temperature are characteristic, especially in winter, and are often of a very marked type. To these inversions the author devotes considerable attention, the subject being one to which, as far as we can recall, only somewhat casual reference has hitherto been made in the literature of polar meteorology. All the observations known to Dr. Pollog which show the occurrence of inversions are given. These include captive balloon, kite, and *ballons sondes* records, as well as observations made at fixed stations at different altitudes. Thermal, not orographic controls are the chief factors here concerned. There being few observations from above the surface, an indirect method of recognizing inversions was employed. Dr. Pollog takes the position that when the observations at a station show that winds from any direction brought a rise of temperature, an inversion of temperature must have been present. This criterion is obviously not as safe as the evidence of actual observations, but it may serve in default of other more trustworthy data. A tabulation is made of the available observations which show a rise of temperature with winds following calms and therefore presumably indicate preceding inversions.

Another point is also brought out. When water at a relatively high temperature (i. e. not below freezing) is found under a polar ice cover a certain amount of heat will pass from the water through the ice and in turn affect the air above the ice. The annual temperature minimum is thereby flattened out, two or even more months having the same, or approximately the same temperature. Hann called a winter having a temperature curve of this type *kernlos*.

Dr. Pollog's discussion leads to a classification of the types of polar climates. Polar marine climates characteristically have a flattened winter minimum. In polar continental climates, concerning which there is very little information, cooling by radiation is at a maximum, and the annual march of temperature is similar to that of land areas in more temperate latitudes. Polar transition climates are classed as subpolar and "ekpolar." The former occur where snow and ice do not remain throughout the year but where the winter is sharply defined. "Ekpolar" climates are found on land areas where the snow disappears from the surface in summer but the lakes remain ice-covered well into the warm months.

Dr. Pollog's paper contains a bibliography of over 150 titles, several pages of temperature data for the polar zones, and numerous illustrative temperature curves.

R. De C. Ward

The Scoresby Log Books. The Explorers Club of New York has distributed its reproduction (printed 1916 and 1917 in limited edition) of the Scoresby log books. The title page of the introductory brochure runs "Seven Log-Books Concerning the Arctic Voyages of Captain William Scoresby, Senior, of Whitby, England." The

originals were lent for this purpose from the library of the American descendants of Scoresby's younger son Thomas. The books, seven in number, are in facsimile and pertain to 14 voyages into the Arctic Seas around Spitsbergen and eastern Greenland. The introductory brochure, edited by F. S. Dellenbaugh, includes portraits of the captain and his sons, William Jr. and Thomas, maps illustrating his discoveries, and several illustrations from the works of William Jr.

The Scoresbys hold a unique place in Arctic annals for their remarkable combination of scientific discovery with successful commercial ventures. The chief credit of the former "goes naturally to William, Junior, for the reason that his father specially educated and trained him in that direction and he made trigonometrical surveys and exact observations which he recorded in his books and maps." These works are well known: there has been little accessible regarding the father. He was, says Mr. Dellenbaugh, "probably the most successful whaler and ice navigator that ever lived. In all his total of thirty voyages as commander into the dangerous Arctic waters he never lost a ship; nor did he ever have one seriously damaged. He invented the top-gallant 'crow's nest' (the first one built in 1807 and in use ever after), the ice drill, and numerous things connected with the operations of whaling. He was the first on record after Hudson to trace the east coast of what was then called 'West' Greenland, as distinguished from Spitsbergen, at that time called Greenland and 'East' Greenland."

In 1806 Scoresby accompanied by William Jr., then aged 17 (his first Arctic voyage was made at the age of 10), attained the highest north of the time, 81° 30′ on May 24 in longitude 19° E. It was not superseded until Parry's voyage of 1827. The stimulation in Polar interest, of which Parry's voyage and the efforts for the Northwest Passage are the product, was itself in large measure due to the representations of the Scoresbys, father and son. Finally the name Scoresby Sound on the eastern coast of Greenland is a record of the brilliant piece of exploration carried out on its shores by the great whaling captain on his last voyage, in 1822.

MATHEMATICAL GEOGRAPHY

Progress in Aerial Surveying. To the general student of geography and especially to those interested in the making of maps the rapid progress since the war of methods whereby maps may be constructed from aerial photographs is of great importance.

In 1923 the Air Survey Committee of the British War Office issued a report (H. M. Stationery Office, London, 1924) which may be taken as a comprehensive summary of the history of the development of aerial map making and the general opinions and conclusions that had been arrived at by those engaged in research work on this subject in the United States, the British Empire, and Europe generally up to 1923. An excellent bibliography has been compiled, together with a list of the terms and definitions adopted by the Committee. On page 73 of this report it is stated that "The committee are of the opinion that no one method of surveying will prove suitable in all cases, nor do they consider that air phototopography will be found efficient and economical if employed to the exclusion of occasional or even frequent measurement on the ground. . . . Just as there are many different methods of ground survey, so survey from air photographs is already evolving on several different lines, each of which has its applicability."

Since the report was published the general conclusions arrived at therein have not been materially changed, but the tendency has been to concentrate research on the possibility of combining the advantages of "vertical" and "oblique" photography together, so that accurate intervals of height may be determined from the air alone, that control points on the ground need not be so numerous, and also that the "mosaic" method of constructing a map from photographs may be eliminated.

Methods seem to be developing somewhat along the lines suggested first perhaps by H. Roussilhe. A review of his methods by Major J. W. Bagley has already appeared in this publication (Concerning Aerial Photographic Mapping: A Review, *Geogr. Rev.*, Vol. 12, 1922, pp. 628–635). The research work recently done in the United States is well described in a paper entitled "Development of Aerial Photographic Mapping in the Army," also by Major Bagley, and presented before the Board of Surveys and Maps in February, 1925.

The Fairchild Aerial Surveys, Inc., have recently begun publication of a series of interesting bulletins on the subject under consideration. Up to the time of writing (May 4, 1925) two numbers have been issued, and they have taken the form of reprints from articles first published in other journals. The first article is by Gerard H. Matthes of the Fairchild Company, and the various commercial and other uses to which aerial photography may be put are described by him. He is careful to make it clear that aerial photography is not a complete system of mapping in itself; rather that it is the best, quickest, and possibly cheapest method of obtaining topographical detail in plan. For certain special purposes (mostly commercial) the aerial photograph by itself is sufficient in what it depicts, even though errors of scale due to various kinds of distortion are not eliminated and it is only possible to guess at the differences of height in the terrain. The second article is by Major Harold C. Fiske and describes the original methods devised and used by him in the aerial survey of the Tennessee River valley. It would appear likely that his system of "radial control" will be much employed in the future.

PHYSICAL GEOGRAPHY

New Studies on Postglacial Time. Dr. Ernst Antevs' work in New England on certain clay layers as markers of geological time has advanced to a new stage. After substantial aid from the National Research Council and the American Geographical Society (see "The Recession of the Last Ice Sheet in New England," *Amer. Geogr. Soc. Research Series No. 11*) and the Geological Survey of Canada (see "The Retreat of the Last Ice Sheet in Eastern Canada," *Geol. Surv. Canada Memoir 146*) he was appointed on the Shaler Memorial Fund of Harvard University for a term of two years; and he is now preparing a definitive report on his latest field work. Applying in part the method of his old master, Baron Gerard De Geer of Stockholm, he is working out the late-Quaternary physiographic development of the glaciated area and a late glacial chronology of extraordinary interest and value in determining the time represented by the waning of the last great continental ice sheet. In the summer of 1924 Mr. Erik Norin of Stockholm, on Baron De Geer's initiative and chiefly under the auspices of the Swedish Geographical Society, studied Pleistocene glaciation and its waning in Kashmir, Baltistan, and Ladakh in the northwestern part of the Himalayas (see *Ymer*, Vol. 44, pp. 444–447). At the beginning of April this year Mr. Norin, accompanied by Mr. Anton Sörlin, again departed for the same regions in order to continue the studies. He is supported by the Swedish Geographical Society and the University of Stockholm. News has also been received that Dr. Carl C. Caldenius of Stockholm has been engaged by the Geological Survey of Argentina for geochronological studies of the same type and with special attention to the problem of the contemporaneity of the glaciations of the southern and northern hemispheres.

In this connection it is of special interest to note a detailed analysis of a particular region and its bearing on Antevs' work. John H. Cook in "The Disappearance of the Last Glacial Ice Sheet from Eastern New York" (*New York State Museum Bull. No. 251*, March, 1924, pp. 158–176) has made a brief preliminary study of the mode in which ice "retreats" from a land over which it has been spread as a continental

sheet. He states that the facts upon which earlier explanations or descriptions have been based are relatively meager and that there is need for a critical inquiry based upon a closer examination of the several hypotheses of retreat and of detailed rather than general field evidence. It is concluded that stagnant ice and associated "waters-of-melting" played the principal rôle in shaping the recessional drift. There is found to be an early breaking up of parts of the ice sheet back of the outer border by the hydrostatic pressure of accumulated water. Despite this action and its effects upon fluvioglacial sediments the author concludes "that the possible contemporaneity of laminated clays as far separated as, for example, the southern foothills of the Adirondacks . . . and the northern edge of Shawungunk Mountain . . ." do not of necessity vitiate "the value of the chronology worked out by Antevs."

The Area of Interior Basin Drainage. In the *Comptes Rendus* of the French Academy of Sciences for March 23, 1925 (Vol. 180, pp. 939–942), appears an important note by MM. E. de Martonne and L. Aufrère on the "Extension du drainage océanique." With the aid of students at the Institut de Géographie the authors have made a detailed calculation of the areas of oceanic and interior basin drainage where heretofore we have had only approximate determinations. They assign a notably higher proportion to the inland drainage, 26 per cent of the total land area—or 30 per cent abstraction being made of the Polar regions—where Murray (1886) gave 18 per cent and Penck (1894) 22 per cent. Results are given by continents, by 1° zones of latitude and 10° means. In Australia only 41 per cent of the drainage is to the sea, in Africa 57, Eurasia 68. The New World in contrast is well drained, South America 86 per cent, North America 90 per cent.

Inland drainage is mainly a function of climate and orography. Geological conditions are much less significant: in the calculation small interior-basin drainage in limestone countries has been ignored. The relation with climate comes out markedly when distribution by 10° means is considered, as is indicated by the following table, in which L = latitude, D I = per cent area of interior drainage, and F = P:T + 10 where P is the annual precipitation in centimeters and T is temperature in degrees Centigrade.

	N							S				
L	60	50	40	30	20	10	0	10	20	30	40	50
DI	6	22	44	53	55	29	5	2	37	56	59	16
F	5.1	3.3	1.9	1.6	1.3	3.5	5.3	4.3	2.3	1.7	2.2	4.4

Concordance is especially well marked in the northern hemisphere; in the south data are less certain, and the comparative narrowness of the continental areas means that the effect of local anomalies is more pronounced. Evaporation, controlled especially by temperature, and precipitation are the essential facts. There seem to be certain limiting values of temperature (below 0° C.) and of rainfall (above 1 meter). Where the climatic functions are balanced, i. e. where P = T + 10 is less than 3, relief becomes the deciding factor.

Tropical Cyclones in the North Atlantic Ocean. The United States Weather Bureau has recently issued, as *Supplement No. 24* of the *Monthly Weather Review*, a valuable study by Charles L. Mitchell on "West Indian Hurricanes and Other

Tropical Cyclones of the North Atlantic Ocean." This is the third extended paper on West Indian hurricanes contributed by the Weather Bureau meteorologists, the older ones being E. B. Garriott's (*U. S. Weather Bur. Bull. H*, 1900) and O. L. Fassig's (*U. S. Weather Bur. Bull. X*, 1913). Mitchell's study is less comprehensive than these earlier ones in some respects, omitting, for example, comment on the destructiveness of the storms; but it deals very much more fully than its predecessors with the place of origin and the track of storms. Upon eight maps (14 x 10 inches) of the North Atlantic are given the approximate tracks of the 239 tropical cyclones occurring in the months of June to November, inclusive, for the years 1887 to 1923. September and October, the stormiest months, each have two charts. Thus the charts are not crowded with tracks. The storms are classified into those of known hurricane intensity (51 per cent), doubtful intensity, and minor intensity (25 per cent). The tracks of each class are differentiated on the charts, which also show the approximate daily position of each storm center and whether or not the storm filled up on the last day shown. Mitchell took special pains to determine the approximate place of origin of the cyclones and found that none originated in the eastern two-thirds of the Caribbean, whereas many develop in the western third and east of the Lesser Antilles. More than a dozen hurricanes are shown to have originated in August and September near the Cape Verde Islands, and one on the coast of Africa. These eight large charts form by far the most satisfactory series of tropical cyclone tracks known to the reviewer. Two other notable series of maps are given. One shows for each of the hurricane months the average 24-hour movement of tropical storms. The other series is several daily weather maps, for each of ten storms. A table gives the average direction and velocity of movement of storms in two-and-a-half degree squares. The other table gives facts as to the origin, recurve, and duration of each of the storms by months. Forty lasted two weeks or longer, five lasted three weeks or longer, and one was traced for 36 days. Several storms were traced from near Cape Verde Islands west to the Antilles and northwest to beyond Iceland.

STEPHEN S. VISHER.

HUMAN GEOGRAPHY

Settlement on the Border with Government Aid. From the time when a national policy of "internal improvements" gave us wagon roads over the Alleghanies and connecting canals between our rivers, down to the present when a government policy of forest, water power, and irrigation control is of national scope, the problem of the pioneer has enlisted public interest. How far should aid go? What form should it take? Does it pay? These are among the almost unsolvable problems of a paternalistic policy.

Questions of this type are at the fore in Australia today. A recent phase is illustrated by the agreement recently signed between the governments of Great Britain and Australia for the purpose of providing capital to be used in the settlement and development of rural areas. According to the London *Times* (weekly edition, April 16, 1925), it is the intention to settle, in the next ten years, 450,000 assisted emigrants from the United Kingdom, including 34,000 families averaging five persons each, upon "agreed understandings," which include the clearing of land; advances to settlers for the purchase of stock, equipment, and housing materials; construction of roads, bridges, and light railways; afforestation; construction of hydro-electric and water-conservation works, butter factories, sugar mills, and the like. The British government will pay, subject to the conditions of the Empire Settlement Act of 1922, a contribution toward the cost of passages in the proportion of about £130,000 for every sum of £750,000 issued by the Commonwealth Government to a given state government. Each contribution of this size will be dependent on the satisfactory settlement of 10,000 assisted emigrants in a given state within a

period of ten years. Half of the farms made available under the plan are to be reserved for emigrants from the United Kingdom.

In connection with this plan it is interesting to note that press dispatches during May contained rather pessimistic reports from the Secretary of the Interior of the United States regarding the exodus from irrigation projects of settlers established upon newly reclaimed land in the arid West by the United States Government. The chief difficulty is to attract settlers to the projects under conditions of payment for land which will enable them to live and at the same time to reimburse the government for the costs of construction. The Department is now trying to discover a better mode of land settlement and to this end is conferring with railway immigration agents and state governments in order to obtain the assistance of every possible agency. New projects are being scrutinized as to their feasibility for settlement, for while "the Reclamation Service can build irrigation works . . . it cannot draft settlers." These difficulties are of special importance because Congress has already been generous in permitting the deferment of payments in the case of settlers who found themselves in financial difficulty. The problem has become acute because of the request for wholesale relief on the part of entire immigration districts composed of hundreds of farmers.

The problem has been fully stated in the report "Federal Reclamation by Irrigation" (*68th Congr., 1st Sess., Senate Doc. No. 92*, 1924), by a committee of special advisers on reclamation. From it we quote two significant paragraphs.

"The situation that has developed on the Federal reclamation projects is serious. Three projects have been abandoned, and unless remedial measures, of a permanent character are applied, several more of the projects will fail; and the Federal reclamation experiment conceived in a spirit of wise and lofty statesmanship, will become discredited.

"Success can come to future Federal reclamation ventures only if projects are authorized upon a thoroughly scientific consideration of the probable power of the project to enable the farmer to repay construction costs and to win a living from the irrigated lands. Community and political demand to secure projects should be considered only after full knowledge of the feasibility of a proposed project has been secured."

It would also seem of interest to place side by side with the above a quotation from an article by H. Heaton "The Taxation of Unimproved Value of Land in Australia," appearing in the May, 1925, number of the *Quarterly Journal of Economics*. "The further development of close settlement is faced with difficulties. There is a land hunger which cannot be met. . . . In spite of the spending of vast sums on railways, roads, land-resumption, assisted immigration, and advances to settlers, there were only 90,000 more people engaged in agriculture in 1921 than in 1891. The capital cities house 43 percent of the whole population. Decaying rural towns are dotted all over the map of eastern Australia.

"During the past seven years three parliamentary committees have asked why these things should be. The answers are many. . . . But most important of all is the lack of any further supply of good crown land. Statistically it is true that Australia has an area of over 3,000,000 square miles. But in terms of quality, considering especially rainfall from the point of view of quantity, certainty, and season, only about one quarter of the continent is fitted for close settlement by the white race . . . the eastern and southeastern strip of the continent, along with the southwest corner, and parts of Tasmania. But virtually all the land in those areas has already been taken up; on it one finds about 5,250,000 people out of the total 5,600,000. . . . Any further growth of rural settlement means either a more intensive and better use of land already occupied, or the expenditure of vast sums on railways, public works, and water supplies for the semi-arid fringe beyond the settled area."

Geography and Railroad Consolidation. In both the United States and Great Britain the post-war period has been characterized by movements toward railroad consolidation. In this country the Transportation Act of 1920 amended the Act to Regulate Commerce of 1887 in such a way that the Interstate Commerce Commission is now called upon, among other duties, "to prepare and adopt a plan for the consolidation of the railway properties of the continental United States into a limited number of systems." Under this plan competition is to "be preserved as fully as possible and wherever practicable the existing routes and channels of trade and commerce" are to "be maintained."

In 1921 the Commission drew up a tentative plan which provided for the consolidation of the railroads of the country into nineteen systems and was "put forward in order to elicit a full record upon which the plan to be ultimately adopted can rest." Accompanying the tentative plan was an extensive report, fully illustrated with sketch maps and statistics, by Professor W. Z. Ripley of Harvard University (*Interstate Commerce Commission Repts.*, Vol. 63, 1922, pp. 455–660). Since then "an immense mass of descriptive and statistical material has been accumulated." The geographer will find invaluable data in Professor Ripley's preliminary report with which should be read a stimulating paper entitled "Geographical Limitations of Consolidated Systems" which Professor Ripley presented before the annual meeting of the American Economic Association at Washington in December, 1923 (*Amer. Econ. Rev.*, Vol. 14, No. 1, *Suppl.*, 1924, pp. 52–64). Walter M. W. Spawn, "The Consolidation of Railroads," Macmillan Co., New York, 1925, should be consulted for observations on subsequent developments.

The railway network of the country may be split into three "long-standing rate-making areas and statistical divisions which have commended themselves upon the basis of long experience to the parties concerned." These are: the trunk line area of the northeast, the area south of the Potomac and Ohio rivers and east of the Mississippi, and the area west of the Mississippi. The failure of various ambitious plans to constitute systems covering a wider territory than these historic areas has shown that "any substantial system must have breadth as well as length, an amplitude of feeders as well as main stems" and that "there seems withal to be a pretty clearly defined upper limit of aggregate mileage which may be efficiently operated" (*I. C. C. Rept.*, Vol. 63, p. 480). "Mileage and the volume of business may indeed easily enough overpass the limits of human ability in management, and this is especially true where the diversity of geographical conditions and the variety of tonnage are very great" (*Amer. Econ. Rev.*, Vol. 14, No. 1, *Suppl.*, p. 62).

Within the maximum limits which thus seem to be imposed by geographical considerations upon the magnitude of railway consolidations, we have a wide variety of possible "geographic types of railroad layout." These varying types, other things being equal, exert a potent influence upon the stability and prosperity of any system. It would seem almost axiomatic in railway management that the long haul is more profitable than the short haul, for the latter involves the relatively high expenses incident to the assembly and delivery of freight as well as to terminal services, which always impose a special burden. A well-balanced railway system should admit of sufficient profit through long-haul business to make good the losses in those parts of the organization where short hauls predominate. How far this is possible is to a large extent dependent upon the geographic type of the railway layout.

Professor Ripley describes five such types. In the first place there is the string type which, as long as the string connects important cities or centers of population, may be advantageous from the financial point of view. The second, or tree type, which has its "roots at a major traffic center and its branches well distributed at the farther end," may prove to be an extremely profitable layout, as in the case of the Santa Fe or Illinois Central. "A third type geographically is suggested by the

dead tree from whose roots have sprung forth a lot of suckers. There is a long stem, to be sure, but the suckers do not feed into it." In the fourth, or fan-shaped type, such as the Boston and Maine or the Missouri Pacific, "there is the maximum short haul without the compensating advantage anywhere of the consolidated long haul." The fifth type is that of the "system shaped rather like the diagonals of a square, with important traffic centers at the four corners," as in the case of the Southern or the Louisville and Nashville. "Both of these roads, based respectively on Richmond, Florida, New Orleans, and St. Louis are always certain to enjoy long hauls down the diagonals, and they can afford, of course, to carry an intermediate body of branches and feeders thereby" (*ibid.*, pp. 59–61).

Professor Ripley concludes that "the task of the geographic student of railroad consolidation should be to relegate" considerations of mere "size to second place and to emphasize structure instead. Thus doing, one should then proceed to formulate boldly an ideal general plan, based upon the broadest considerations of economic statesmanship. . . . The consolidation mandate of the Transportation Act of 1920, thus regarded, becomes at once an economic challenge and a wonderful opportunity" (*ibid.*, p. 64).

The situation in Great Britain is interesting as emphasizing the complete contrast between British and American practice and ideals. From the practical standpoint it must be remembered that in Great Britain long hauls (over 200 miles) are the exception rather than the rule but that on the other hand traffic is considerably more intensive than in America. During the war railways were virtually under the control of the government, which guaranteed them a net profit based on their pre-war earnings. The exigencies of the war left the railways in an exhausted condition, running expenses had increased out of proportion to rate increases, and when the time came for withdrawing the financial guarantee the financially weak railways saw bankruptcy staring them in the face. The alternate remedies suggested were the nationalization of all railways or the amalgamation of strong and weak systems into groups. Only the second remedy received the necessary political and financial approval.

Contrary to the spirit of the United States Transportation Act of 1920 the aim in Britain was to eliminate what was called "wasteful competition" but to do so with the minimum of legislation and in the shortest time. It was therefore decided that, whatever grouping arrangements resulted, no effort should be made to split up scientifically the weak railways and apportion their disintegrated sections to the larger groups having the most use for them. No bargaining or interchange of sections should be made between one group and another, and no solution of the joint line problem should be sought for. Railways were to be bodily united together: that was all.

The grouping scheme called for by an Act of 1921 and put into effect on January 1, 1923, is consequently simply a compromise between conflicting interests. In general it comprises four large groups, each having more or less monopoly over the area it covers. These groups are the Southern, the Western, the Northwestern, and the Northeastern. All converge on London. The Southern group is the network of lines radiating like a cobweb from London to the south coast of England. It boasts of seven short but independent main lines on each of which traffic is as intensive as on the Pennsylvania main line between New York and Philadelphia. The Western group is another cobweb system with lines radiating as far south as Plymouth and as far north as Liverpool. By absorption of all the small but lucrative coal railways in South Wales it now practically controls the transportation to and from that very important region.

The Northwestern and Northeastern groups, as their names imply, cover the remaining country to the north. Each is an unsystematic conglomeration of large and small railroads. Each penetrates, but not very effectively, into its neighbor's

territory. In Scotland, on the other hand, the territorial dividing line between these two systems ceases to exist. Each group serves all important towns in Scotland but in such a way as not to compete directly except in one or two cases. This is because the Northwestern group radiates from Glasgow and the Northeastern from Edinburgh.

Part of the new Northwestern group—or the London, Midland and Scottish Railway as it is called—consists of the old Midland and the London and Northwestern railways. These two powerful systems used to compete with about equal success for the traffic between the four largest cities in Great Britain, namely, London, Manchester, Liverpool, and Glasgow. This traffic, therefore, is now monopolized by one group. Nevertheless, active and direct competition still exists in other parts of the country. With the exception of Glasgow, as noted above, there is bitter and intense rivalry between the Northwestern and Northeastern systems over their through Anglo-Scottish traffic. Such centers as Leeds, Sheffield, Nottingham, Leicester, Birmingham, and Plymouth, being situated on the border lines between groups, still enjoy the competitive state of affairs.

For a summary of the Railways Act of 1921 (Great Britain) with maps see the Railway Year Book for either 1922–23 or for 1924. See also W. E. Sinnett, "Railway Amalgamation in Great Britain," London, 1924. The firms of Bartholomew and of Philip have published colored maps showing the new grouping.

Conference on the Food Supply of the Pacific. Among a number of agencies engaged in scientific work in the Pacific area is the Pan-Pacific Union, which has followed up several conferences by establishing a research institution and which has now published the "Proceedings of the First Pan-Pacific Food Conservation Conference," held under the auspices of the Union at Honolulu, Hawaii, July 31 to August 14, 1924. Among the resolutions which were passed are three of special interest in geography: (1) a recommendation that accurate scientific surveys be made of lands which may constitute permanent breeding grounds of locusts in order to anticipate devastating flights and to begin preventive measures; (2) a recommendation that the Congress to be held in Japan in 1926 should be preceded by surveys of the rice problems of the various countries in order to increase production; (3) a recommendation that crop forecasts or complete and timely statistics of food consumption and production should be published in readily available form. The papers in the volume relate to a wide field, but the most important from a geographical standpoint are those having to do with an increase in the food supply in countries bordering on the Pacific and on the islands of the Pacific. There is an especially interesting photograph of Kahalui Harbor and a large number of valuable photographs from Pacific countries. In what appears to be the only general map of the Pacific in the whole volume, page 468, there is an extremely small scale representation of the Pacific area which emphasizes Hawaii's position at the crossroads of the Pacific (a slogan of the Union), but the wisdom may be questioned of representing the Hawaiian Islands on a scale so enormously exaggerated with respect to other lands.

The Geography of Disease. That there is a "geography of disease" is readily granted. Numerous distributional maps show it. M. Neveu-Lemaire has many examples in his "Notes de géographie médicale," published in *La Géographie*, 1920–1923, and now appearing in book form, wherein he discusses various maladies of more or less restricted and well-defined geographical locus. Climatic conditions have commonly been accepted as one of the principal factors in such cases. The term "tropical diseases" conveys the idea. It is a little misleading perhaps, for in general no simple direct relation exists: recent advance in medical knowledge emphasizes the complexity of relations.

This is the point made by M. Brunhes in the new edition of his "Géographie humaine" (1925) in the section "Géographie des malades" written with the collaboration of L. Nattan-Larrier. It has been largely inspired by the World War which demonstrated in an unparalleled manner the connection between great economic disturbances and hygienic equilibrium. Among the armies on the Western Front, in spite of the precaution exercised, there were epidemics of various "exotic" diseases. In the summer of 1915, for instance, amoebic ("tropical") dysentery broke out in the trenches. The parasite of the disease brought by returned troops from the Orient found in the mud of the trenches conditions similar enough to the rice fields and flourished accordingly. At the close of the war the epidemic ceased without resort to any special measures. The same was the case with malaria, the so-called "trench fever" closely similar to a disease common in the coal mines of Japan where it is carried by the rat, typhus, and other ills. The history of other exotic diseases shows similar connections. We do not think of leprosy as a European disease though autochthonous cases are known in France and other European countries, as are cases of amoebic dysentery, yet is was common in medieval Europe. It is rare that cholera escapes from its Asiatic foyers, though plague-carrying rats and the lice that act as intermediary hosts are known in many ports (on the spread of the great cholera epidemics see Map 1 accompanying Johannes Wütschke: Die geographische Verbreitung von Krankheiten, *Petermanns Mitt.*, Vol. 67, 1921, pp. 53–57). It is simply that social and economic conditions have changed. Typhus and relapsing fever are still endemic in certain east European and Asiatic centers where filthy and wretched living conditions prevail. In short, the human element plays a most important part in the geography of disease—in its modifications of the environment, its relation to what Brunhes terms "the essential facts," house, mine, field and flocks, and in its migrations.

GEOGRAPHICAL NEWS

A New Journal: "Economic Geography." With the March, 1925, number Clark University initiates the publication of a quarterly magazine *Economic Geography*. The foreword speaks of "the need for a full knowledge of the natural resources of the world, and a better understanding of the natural conditions to which man must the more carefully adapt himself as population increases and the burden upon the land is made heavier," and expresses the aim of the magazine as service in this field. The series of articles in the first issue exemplifies the merit of the aim.

W. B. Greeley, Chief of the United States Forest Service, in "The Relation of Geography to Timber Supply" deals with the domestic situation, outlining the steps by which present conditions have been reached. He concludes that "forestry not only is the only way to re-establish an adequate source of timber in the United States: it is the only way to utilize a large part of her land—to maintain a vigorous rural population with industries, communities and good roads. On both counts, forestry should become part and parcel of our program of land utilization." A broader aspect of economic land utilization is the theme of the paper "A Land Policy for the Public Domain," by George Stewart, of the Utah Agricultural Experiment Station. Two papers dealing specifically with Canadian topics illustrate the closeness of economic relations between the Dominion and the United States. "The Grain Trade of Montreal," by Clarence F. Jones, of Clark University, makes use of effective comparison between Montreal and New York as grain ports. In "The Coal Resources of Canada" M. J. Patton, of the Natural Resources Intelligence Service of Canada, defines Canada's "fuel problem" as one not of supply but of distribution, whence she is "peculiarly dependent on the coal-fields of the United States." "The Relation Between the Distribution of Population and of Cultivated Land in the Scandinavian Countries, Especially in Sweden," by Olof Jonasson, of

the University of Stockholm, gives an interesting review of one of the most interesting phases of recent geographical work in Scandinavia.

Of widest general interest is O. E. Baker's paper, "The Potential Supply of Wheat." Consideration of the food problem of the future based on present trends leads to an estimate that the production of wheat would have to be trebled in the next century. Examination of the physical conditions of wheat production indicates a possibility (as regards climate, topography, soil) of extension of the area from the 500,000 square miles now under cultivation to 5,500,000 square miles distributed roughly in the following (per cent) proportion: North America 25; South America 9; Europe 27; Asia 27; Africa 9; Australasia 3. Economic principles, however, would not permit of such a development. From a study of the geography of production figures are arrived at for the world's potential production. The world production in 1923 was about 4 billion bushels; future production is forecast at something over 12 billion bushels. Dr. Baker's paper, as indeed all of the papers, is lavishly illustrated.

Following the articles are sections devoted to Book Reviews, to the contents of contemporary numbers of American magazines of geography and related fields, and to News Items. Wallace W. Atwood is Editor; O. E. Baker, Clarence F. Jones, Samuel J. Brandenburg, Associate Editors; W. Elmer Ekblaw, Managing Editor.

Obituary

John Fillmore Hayford. John Fillmore Hayford, director of the College of Engineering at Northwestern University, died March 10, 1925, aged 57. Dr. Hayford's name is specially associated with the theory of isostasy. "Its establishment was due more to Mr. Hayford than to any one man," said the President of the Royal Geographical Society in making him the award of the Society's Victoria Medal in 1924. On this occasion his report, "The Effect of Topography and Isostatic Compensation Upon the Intensity of Gravity," presented at the 1909 meeting of the International Geodetic Association, was described as "a classic of geodesy." A more complete statement made with the collaboration of Dr. William Bowie appeared in 1912 as *Coast and Geodetic Survey Special Publication No. 10.* In the general statement to this paper reference is made to the bearing of isostasy on determinations of the figure of the earth. Dr. Hayford's computation (1910) was adopted as the standard figure at the Madrid meeting of the International Union of Geodesy and Geophysics at Madrid in 1924. A further list of Dr. Hayford's writings on the subject may be found in the "Bibliography of Isostasy" compiled by Adolph Knopf and issued by the Division of Geology and Geography of the National Research Council.

Dr. Hayford's earlier work included service on a commission to determine the boundary between Panama and Costa Rica; his later work an investigation (commenced in 1911) of the laws of evaporation and stream flow undertaken for the Carnegie Institution of Washington. The Great Lakes furnished the experimental material, and important results had been achieved, some of which are given in the Institution's publication "Effects of Winds and Barometric Pressures on the Great Lakes" (1922). The studies had direct bearing on local problems of navigation and power and on the question of the Chicago Drainage Canal, as Dr. Hayford outlined in his paper "The Best Use of the Waters of the Great Lakes," in the December, 1924, number of the *Scientific Monthly.*

Henri Cordier. On March 16, 1925, occurred the death of a great student of the history of exploration and one of the foremost Orientalists of recent times, Henri Cordier, Professor at the École des Langues Orientales Vivantes in Paris. Recognition of Cordier's contributions to geography came at the end of a long life

—1849 was the year of his birth—in the form of the presidency of the Geographical Section of the Committee on Historical and Scientific Work of the Ministry of Public Instruction and Fine Arts, to which post he succeeded Vidal de la Blache in 1918, and in his election to the presidency of the Société de Géographie of Paris in 1924 as successor of Prince Roland Bonaparte. His wider services to French scholarship were signalized through election to membership of the Institute of France.

Cordier's interests were broad. The bare titles of his many published works show this. They centered, however, in the history and geography of the Far East and more particularly in the history of Occidental enterprise in the Orient—whether of exploration, commerce, or politics. For more than thirty years he was the editor of the periodical *T'oung Pao, ou Archives Concernant l'Histoire, les Langues, la Géographie, et l'Ethnographie de l'Asie Orientale*, well known to all Orientalists. His major publications fall into four groups: synthetic histories, geographical works, editions of earlier geographical and historical works, and, finally, bibliographies. In the first group belong the great "Histoire des relations de la Chine avec les puissances occidentales, 1860–1900," 3 vols., Paris, 1901–1902; the diplomatic history of the British expedition into China in 1857–1858 (L'Expédition de Chine de 1857–1858, Paris, 1905), and the author's last published work of large scope, the "Histoire générale de la Chine et de ses relations avec les pays étrangers depuis les temps les plus anciens jusqu'à la chute de la dynastie mandchoue," 4 vols., Paris, 1920–1921. The publications dealing strictly with modern geography were less ambitious; they include the article on China in the "Grande encyclopédie," a small volume on China in the "Collection Payot" (Paris, 1921), and a book of travels in South Africa, "Le périple d'Afrique: Du Cap au Zambèse," Paris, 1906. Cordier, however, is probably best known to English-speaking geographers and historians for his publications of the third group. The magnificent series in twenty-three volumes known as "Recueil de voyages et de documents pour servir à l'histoire de la géographie depuis le XIII^{e} jusqu'à la fin de XVI^{e} siècle" appeared under the joint direction of Cordier and Charles Schefer; to it the former contributed a volume on Oderic of Pordenone. Cordier's edition of Sir Henry Yule's translation of the "Book of Ser Marco Polo," (2 vols., London, 1903, with supplementary volume of notes and addenda, "Ser Marco Polo," New York, 1920) is familiar to all devotees of the Venetian wanderer. Cordier also edited in English for the Hakluyt Society the second edition of Yule's "Cathay and the Way Thither," (4 vols., London, 1913–1916). And finally, mention should be made in this category of a four volume series of texts edited by Cordier under the title "Documents historiques et géographiques relatifs à l'Indo-chine," Paris, 1910–1914. No student of the Far East can dispense with Cordier's great bibliographies. Of huge proportions and extremely comprehensive range are the "Bibliotheca Sinica" (Paris, 1904) and "Bibliotheca Indosinica" (Paris, 1912–1915), each in four volumes. The "Bibliotheca Japonica," (Paris, 1912) is a more modest publication in one volume.

Besides these major items are many contributions to periodicals. Some of those dealing with America were included in "Mélanges américains," Paris, 1913. Others relating to Oriental topics were gathered together in the "Mélanges d'histoire et de géographie orientales," the first two volumes of which appeared in Paris in 1914 and 1920 and were reviewed in the *Geographical Review*, Vol. 11, 1921, pp. 638–639. The last two volumes, Paris, 1922, 1923, are similar in general nature to the earlier ones, containing material which at the time of its original publication threw new light upon many interesting topics. Among this material, geographers will find an article dealing with an episode in the life of D'Entrecasteaux, six new letters of Father J. F. Gerbillon, the explorer of Tibet, and biographical and bibliographical notes on the Orientalists Klaproth and Chavannes.

GEOGRAPHICAL REVIEWS

Travels on the Tibetan Borders

Reginald Farrer. **The Rainbow Bridge.** xi and 383 pp.; map, ills., index. Edward Arnold & Co., London, 1922. 9 x 6½ inches.

F. Kingdon Ward. **The Mystery Rivers of Tibet: A Description of the Little-Known Land Where Asia's Mightiest Rivers Gallop in Harness Through the Narrow Gateway of Tibet, Its Peoples, Fauna, & Flora.** 316 pp.; maps, ills., index. J. B. Lippincott Co., Philadelphia; Seeley, Service & Co., Ltd., London, 1923. $5.00. 9 x 6 inches.

F. Kingdon Ward. **The Romance of Plant Hunting.** xi and 275 pp.; map, ills., indexes. Edward Arnold & Co., London, 1924. 9 x 6 inches.

J. W. Gregory and C. J. Gregory. **To the Alps of Chinese Tibet: An Account of a Journey of Exploration Up To and Among the Snow-Clad Mountains of the Tibetan Frontier.** 321 pp.; maps, diagrs., ills., index. J. B. Lippincott Co., Philadelphia; Seeley, Service & Co., Ltd., London, 1924. $6.00. 9 x 6 inches.

Though avowedly written for the popular reader, each of these four books contributes materially and in its own way toward better understanding of the remote regions lying on the northeastern and southeastern borders of Tibet.

Writing toward the close of the World War, Mr. Farrer explained his title in words which strike the keynote of the volume: "I am writing this book for the relief and release of one person only in the world . . . and, out of my own memories and stored emotions, spinning a rainbow bridge, far-flung over black depths, towards the golden irrecoverable past." The author re-lives a gloriously happy epoch in his life, a long summer season of plant hunting among the high downs and crags of northern Kansu. Personal experiences, trivial incidents, botanical notes, and descriptions of landscapes make up most of the book. There would be no justification for recording these details, were it not for the author's sympathetic knowledge of humanity, his sensitiveness to beauty, and the truly marvelous color and richness of his style. In a two-volume work, "On the Eaves of the World" (Edward Arnold, London, 1917), Mr. Farrer told of his wanderings in search of rare plants along the southern part of the Kansu-Tibetan border in 1914. "The Rainbow Bridge," published postumously, completes the narrative of this expedition as it was concluded in the following year. Mr. Farrer's death in upper Burma in 1920 was indeed a tragic loss to geographical literature.

Captain Ward's two books take us into northwestern Yünnan and western Szechwan where the three great "Mystery of Tibet" rivers, Salween, Mekong, and Yangtze, break southward through the eastern extension of the Himalaya in a remarkable series of parallel valleys. Of the physiography of the region and its bearing on plant and animal life Captain Ward has written elsewhere (see the note, "A Recent Study of Life Zones in Southeastern Asia," *Geogr. Rev.*, Vol. 12, 1922, pp. 140–141.) Captain Ward's main objective, like that of Mr. Farrer, was the search after rare plants for introduction into British gardens. The journey narrated in "The Mystery Rivers of Tibet" was made in 1913 among the mountains near A-tun-tze and to the south down the Salween valley. Captain Ward describes graphically the glacial features and flora of the lower slopes of the Ka-kar-po and Peima ranges and their mighty peaks rising to a height of over 20,000 feet. His expedition down the Salween for a distance of seventy-five miles brought him into the heart of the country of the Lutzu and Lisu—curious, primitive folk about whose

origins and relations there prevails uncertainty. "The Romance of Plant Hunting" is a delightful composite of impressions based on no less than six journeys in these remote provinces of southwestern China.

Professor Gregory and his son in 1922 visited the same general region as Captain Ward. Their primary purpose was to make a comparison of "the physical history of parts of East Africa" (which has already formed the object of well-known researches by Professor Gregory) "with that of southeastern Asia." Their observations, of great importance in relation to the physiography of the entire realm surrounding the Indian Ocean, are briefly indicated in "To the Alps of Chinese Tibet" and set forth at greater length in the *Philosophical Transactions of the Royal Society of London*, Series B, Vol. 213, 1925, pp. 171–298. (See also: *Geogr. Journ.*, Vol. 61, 1923, pp. 153–179).

They believe that the so-called Indo-Malayan mountains, running to the south from Eastern Tibet and far older than the Himalayas, were disturbed by earth movements due to pressure from the north and west during the upheaval of the Himalaya. Associated with the east-west folding of the Himalayan system there was a buckling and fracturing of the earth's surface in a north-south direction. The fractures thus produced are characteristic of Yünnan and appear to have been "contemporary, at least in part, with those that made the Rift Valley system of East Africa, the valley of Mesopotamia with the Persian Gulf, the rugged western front of the peninsula of India . . . and the western edge of the plateau of Australia. . . . Their trend and distribution suggest that they were due to the rending of Africa and south-eastern Asia, when the foundering of the once intervening lands made the basin of the Indian Ocean." Certain of these fractures apparently marked out the lines followed by the Tsangpo-Brahmaputra, the Salween, the Mekong, and the Yangtze Rivers across the grain of the Himalayan structure.

But the Gregorys did not devote themselves exclusively to geology. They lost no opportunity of observing the people. They divide the population of western Yünnan into four main groups, all essentially Mongolian in origin: aborigines, Tibeto-Burmans, Shans, and Chinese. Of all these stocks, they hold that the Chinese is the most vital. "The continuous expansion of Chinese culture and influence is probably the most important and enduring movement now taking place in south-eastern Asia." Their opinion of the Chinese character differs widely from that of Captain Ward, who writes: "Who shall say that China has not within her the germs of that fatal disease which, time and again, burst asunder the Shan Empire as fast as it was reconstructed elsewhere? I mean the deadly germ of disintegration, of mutual repulsion of parts" (The Romance of Plant Hunting, p. 86). The two statements quoted are in themselves not altogether irreconcilable; on the other hand Captain Ward's attitude toward the Chinese as frequently expressed in both of his books would seem to be contradicted by the favorable impression received by the Gregorys.

The Geography of North America

L. Rodwell Jones and P. W. Bryan. **North America: An Historical, Economic, and Regional Geography.** xiii and 537 pp.; maps, diagrs., index. Methuen & Co., Ltd., London, 1924. 21 s. 9 x 5½ inches.

The title of this book is sufficient evidence of its British origin, and it is a notable fact that the first competent work published in the English language on American geography is not of American authorship, Professor J. Russell Smith's "North America" (reviewed in the April number of the *Geogr. Rev.*) having been preceded several months by the work now under consideration. The next thing that strikes

the reader's attention is that the first quarter of the book is given to historical geography, which is a new departure in a general treatise. So-called historical geography often consists of unadulterated history, prefaced or followed by a polite but distant and formal bow to geography. So a second agreeable surprise awaits the reader, who finds that the historical chapters are as truly geographical as those which follow. Thorough use is made of the sources, and the author is not content with generalizations and averages, but does justice to exceptions and extremes. These nine chapters of the senior author on the discovery and early settlement of the continent, the Spanish advance, early French settlement, British tide-water settlements, the Appalachians and the French and British struggle, settlement in Kentucky, the War of Independence and War of 1812, trans-Appalachian routes, and the Civil War, are worthy of separate issue as an example of scientific exposition and literary charm, in which the intimate relations of geographic factors and historical events are clearly set forth.

Scientific topics are never avoided or glossed over but are introduced just where they are needed. The nettles of technical meteorology, oceanography, geology, and physiography are firmly grasped. The pressure and wind charts of the North Atlantic, tides, currents, ice drift, and fogs; the high plateaus and rugged mountains of Mexico; the desert areas and prevailing northerly winds of the Pacific coast; the geological structure of the Laurentian shield, St. Lawrence valley, and Ontario plain; the continental ice sheets; the evolution of the Great Lakes; the history of the Niagara River and the Mohawk-Hudson outlet; the interlocking of Laurentian and Mississippi drainage; the coastal plain and drowned valleys between Florida and Nova Scotia; the structure and relief of the Appalachian barrier and the trans-Appalachian gaps combine the lure of great adventure with rational explanation of the obstacles encountered and the conditions which delayed but made possible ultimate success. Both physiography and history are mutually enlivened and illuminated. There is reason to hope that such exposition may lead to a more cordial recognition on the part of historians of the extent to which human achievement is subject to geographic control.

It is to be regretted that the author has given little attention to the most romantic and interesting movements of people in America, the settlement of the Northwest Territory, the occupation of the Louisiana Purchase, the conquest of the Great Plains, the exploration of the Rocky Mountains and Plateau regions, and the final annexation of the Oregon country and the Spanish Southwest. A book like Paxson's "History of the American Frontier" would disclose events west of the Appalachians as worthy of the pen of the historical geographer as any on the Atlantic seaboard.

In Part II the junior author treats economic geography on the same vigorous and fruitful plan. It opens with an uncompromising chapter on the climates of the United States and proceeds to discuss in 50 pages of unrestrained detail the geographical factors that determine the production, distribution, and marketing of three great staples, cotton, wheat, and maize. Then follow 100 pages on coal, iron, and oil, in which the author pursues with tireless persistence the geological and geographical processes and conditions in any way concerned with the occurrence and utilization of these foundation stones of present day civilization. In 15 pages the structure and relief of the Pittsburgh district are set forth in such detail as to explain (1) the distribution of coal seams, (2) the distribution of coal mined, (3) the origin of the coal, (4) the geological changes that have removed a part and left the rest easily accessible, (5) the history and present régime of the stream systems that give to Pittsburgh its dominant nodality, (6) the extent to which stream valleys favor down-grade transportation, (7) the cutting of the main valleys down to a level slightly above or below that of the coal seams, by which 50 per cent of the coal can be won by drift or up slope, 20 per cent by down slope, and 20 per cent by short shafts, (8) the thickness and uniformity of the coal seams over large areas, favoring the

use of machinery, the short time lost by the miners in reaching their work, and the resulting large output per man and low cost at pit mouth, (9) the terraces of the deep and steep-sided valleys which furnish easy routes for railroads and sites for mining towns. These and other less important physiographic factors are marshaled to form a graphic picture of what seems to be an almost ideal contrivance of nature to supply Americans with cheap coal. With a change of purpose and phrasing, this passage might be converted into a supplementary chapter of Paley's "Natural Theology" or expanded into a "Bridgewater Treatise."

On a similar but smaller canvas are drawn the contrasted features of the anthracite field. Nothing serves like physiographic explanation to make economic statistics palatable, and geography proves more interesting and satisfactory than physiography or economics. The chapters on iron and petroleum are hardly less striking examples of the Sherlock Holmes method, by which the author runs down every trail leading to a natural factor at the bottom of an economic fact.

There is nothing about cement, brick, and stone; and forests and timber receive inadequate notice.

Part III, Regional Geography, by the senior author, discusses twelve regions of North America. It is difficult to understand what criteria the author used in selecting and delimiting these regions and the factors that belong to regional geography. It seems to be a sort of catchall for what is left over from other phases of geography. New England, by nature, history, and tradition a sufficiently well marked region, is given eleven pages, one half more geological than is considered good form by American geographers and the other half mostly economic, the port of Boston occupying two pages.

The next chapter on the Central Lowlands opens with the statement, "Immediately south of the Great Lakes and continuing northwestward into Canada lay one of the very greatest expanses of open, *unforested*, generally fertile land on the surface of the globe." This seems to perpetuate the especially tough old error that Minnesota, Wisconsin, Michigan, Ohio, and Indiana were originally prairie states. Eight pages are given to a rather minute discussion of the glacial drift, six to the Ozark Highlands, and eight to the cities of the Central Lowlands. While the wheat and maize belts have been fully discussed in previous chapters, a Middle Western geographer cannot help feeling that here again, as in the historical part of the book, the author has failed to grasp the fundamental position of the region in American geography.

Mountains and plateaus seem to furnish to the geographer, as well as to the poet, more attractive and usable material than do lowlands. Our author finds it easy to write three times as much about the western half of the United States as about the Central Plains. The writing is generally as picturesque as the country. From such wealth of material he must pick what attracts him and leave the rest untouched. There is enough about irrigation, little about cattle and sheep herding, and nothing about the inhuman deserts and mountains. Probably the book will not be adopted for use in the schools of Los Angeles, to which just six lines are given.

Beginning some sixty pages after New England, the city of New York, the geology and topography of its site, environs, and hinterlands, the commercial corridors which it stretches out like octopus tentacles to draw upon Buffalo, Cleveland, Cincinnati, Chicago, Pittsburgh, Philadelphia, Baltimore, and Boston are graphically depicted, leading to the climax that New York is not only the dominant city of North America but holds a wider and more comprehensive supremacy than any other city in the world. This is well done.

The Appalachian regions and the Atlantic and Gulf Coastal Plains are not included under regional geography. A chapter on Florida illustrates the tendency of the author to confine geography to physiography and economics, seven pages being given to fruit and phosphates and three lines to winter resorts.

The chapters on Mexico, eastern Canada, the Prairie provinces, British Columbia and the Mackenzie basin, and Alaska are more adequate than those dealing with the United States, these regions being relatively unencumbered with geographic complexities.

A score or more of errors in place names are not too many to expect from authors who are writing about a foreign country, and to whom these names are not a part of their daily news reading. There are some slips not thus to be explained, such as mention of California as "the largest of the states," and the now obsolete "whale-back boats" on the Great Lakes. Fargo clay is called glacial, and Lake Agassiz is barely mentioned. No suspicion is indicated that southern New England is not a peneplain. Naturally local phrases are sometimes misunderstood, as "a pudding called hominy" and "boiled meal" for corn mush. The use of Sierra and Cordillera with a plural verb is not a grammatical construction. Some idioms peculiar to British English are none the less unjustifiable, as the superfluous "we have" and "we get" implying there are or there is, and the placing of *only* before the principal verb instead of before the clause or phrase it modifies. These are trifling blemishes easily removed in a second printing. On the whole the authors have been thorough in their search for authentic sources of information, and have fallen into surprisingly few errors. Their work is sound and competent, if incomplete, and in many directions without a rival in its field.

Charles Redaway Dryer

The Defense of the British Empire

D. H. Cole. **Elementary Imperial Military Geography: "General Characteristics of the Empire in Relation to Defence."** vii and 259 pp.; maps, bibliogr. Sifton Praed & Co., Ltd., London, 1924. 8½ x 5½ inches.

The broad scope of this interesting little volume, written by Captain Cole of the British Army Educational Corps, is best indicated by the subtitle: "General Characteristics of the Empire in Relation to Defence." The resources of each part of the Empire in man power and in materials and the lines of communication between its several parts, whether by land, sea, or air, are discussed as elements of the major problem of defending a far-flung empire in time of war. For the most part only strategical questions of a larger sort are considered, and even these are treated in an elementary manner; but the reader will lay down the book with a better appreciation of the strategical background of many political questions which have figured largely in the public press in recent years. Incidentally the American reader will get a new point of view on certain matters affecting the military security of his own country.

In casting up the credits and debits in the ledger of imperial resources, the author justly points out that account must be taken not only of such obvious war materials as iron, nickel, coal, and petroleum, but of all commodities whose lack might bring about the collapse of national resistance. Among such commodities are listed wheat, wool, cotton, and timber, of which the United Kingdom must be able to import from 75 per cent to 100 per cent of the total it consumes if the heart of the Empire is to continue functioning. That the little island kingdom is truly the heart of the great imperial organism in a military even more than in a political sense, will be evident from the following three facts: it is the main technical base, containing the principal reserves of coal and being the chief producer of iron and steel for the Empire; it is the chief owner of shipping, possessing 19,300,000 tons out of a total tonnage for the Empire of 22,000,000 tons; it possesses the main reserve of white man power, 48,000,000 out of a total white population of 66,000,000. It is not surprising, then, that the author should in this part of the work stress chiefly the problem of defending the British Isles.

Far more space is given to the problem of communications, certainly a vital one for an empire on which the sun never sets. If the United Kingdom is the heart, the lines of communication are the arteries of this organism; and the cutting of an important artery is only less dangerous than injury to the heart. For the defense of sea routes a strong navy is essential; but this navy can operate effectively only in case it possesses secure bases along the sea routes where warships may find safe refuge, undergo repairs, take on new supplies of fuel and other provisions and where transports and supply ships may collect in safety to be convoyed to distant points. Hence the strategic significance of such naval bases as Gibraltar, Malta, and many others, the peculiar importance of which is briefly explained in connection with those paths across the sea they are designed to guard. Britain's interest in Egypt can clearly be appreciated only when we realize that the latter country is favorably situated to serve as the base for a hostile attack on the Suez Canal, a most vital link in the main sea route from Great Britain to India; that it is the meeting place of two continents and two seas, the halfway station from eastern Canada to New Zealand, the terminus of the all-British corridor from south to north through Africa, and the future terminus of the Cape-to-Cairo railway. Egypt is, in short, the central junction of the British Empire, the natural barracks from which military forces may be despatched to any threatened point, and the most important nucleus for a system of air routes radiating to various parts of the Empire.

A special chapter is devoted to the petroleum resources of the Empire, because of the importance of this commodity in maintaining communications by sea, land, and air both in time of peace and in war. We are reminded that the whole of the British Empire, including regions directly under British control such as Persia, produces only four per cent of the world's output of petroleum (against the United States' production of 64 per cent) and that during part of 1917 enemy submarine activity had so reduced the stocks of this fuel in Great Britain that the British fleet was unable to function properly.

In the chapter on land frontiers the author describes briefly the rôle of deserts, mountain ranges, swamps, and rivers as strategic frontiers and as defensive barriers in time of war; but the influence of topography upon military operations is very inadequately treated. In view of the lessons of the World War on this point and the dictum of Sir Douglas Haig that the whole conflict might be considered a series of struggles for topographic position, one is perhaps justified in desiring a fuller discussion of the importance of land forms in the strategy of defense, even if tactical problems be not touched upon. The sorry results of boundary making by diplomats ignorant of geographical matters are aptly illustrated by the author with citations of the Canada-Maine and Canada-Alaska boundary disputes.

The last half of the book (save for a chapter on cable and wireless communications and another on imperial organization) is devoted largely to brief sketches of those geographic features of the different parts of the British Empire which are essential to an understanding of imperial military geography. In a new edition the descriptions of general physical features of the regions treated might easily be improved in quality, without appreciable increase in the length of the text. Some historical and other data incorporated in certain of the chapters seem to have not even a remote connection with the subject in hand (e. g. accounts of settlement, dates of receiving constitutions, and other purely political events); but no one will deny that Australia's six different gauges of railways present a problem of potential military concern. A brief bibliography of reference works is appended to the text, as well as a large map to illustrate the hegemony of the Pacific and the *status quo* defined by the treaty for the limitation of naval armaments issuing from the Washington Conference. Altogether the book is a handy compendium of much useful information on military geography, which the layman as well as the specialist can read with pleasure and profit.

DOUGLAS JOHNSON

Economic Geography of Germany

Erwin Scheu. **Deutschlands wirtschaftsgeographische Harmonie.** viii and 175 pp.; maps, diagrs., bibliogr. Ferdinand Hirt, Breslau, 1924. 8½ x 6 inches.

By intention this book has little in the way of principles but much in the way of new material or of old material in new forms. Restricted to Germany, its text of course deals throughout with conditions before and since the war in a comparative manner so that war effects may be considered to be one of the underlying principles of the discussion. There are seventy black-and-white maps, which represent all of the main industrial and agricultural, or, in a word, economic elements. In view of the dislocation of production and trade in Germany and the added difficulties of interpreting statistics since the beginning of inflation it is no little service that the author has done to throw both pre-war conditions and post-war tendencies into orderly form.

On the Southern Border of the Central Andes

Eric von Rosen. **Popular Account of Archaeological Research During the Swedish Chaco-Cordillera-Expedition 1901–1902.** xiv and 168 pp.; map, ills., bibliogr. C. E. Fritze Ltd., Stockholm, 1924. 15 Swedish crowns (18 s.). 12 x 9 inches.

Eric von Rosen. **Ethnographical Research Work During the Swedish Chaco-Cordillera-Expedition 1901–1902.** xiv and 284 pp.; map, ills., bibliogr. C. E. Fritze Ltd., Stockholm, 1924. 20 Swedish crowns (25 s.). 12 x 9 inches.

Partial accounts of the Swedish Chaco-Cordillera Expedition's results have made their appearance at intervals during the past twenty years. These two volumes, which are mutually complementary, sum up and coördinate much that has gone before.

The region treated is that extraordinary stretch of territory in northern Argentina which is divided about evenly between the Andean highlands and the as yet only partly understood wilderness known as *el Gran Chaco*. It is these two sharply contrasted areas that Count von Rosen studies from the point of view of human occupation. Historically, the area is important. The highland parts were probably the seat of more or less advanced societies from an early time, and they were occupied and intensively administered by the Incas during the reigns of Viracocha and Pachacutec, approximately 1400–1450, who succeeded in giving a decidedly "Peruvian" appearance to the material culture of the region.

After 1565 the cordillera of the Argentine Northwest became the seat of a part of that Spanish-American civilization, compounded of elements derived from the American Indians and from the culture of Spain, which extends all the way from our own Southwest down to southern South America.

The first site described by Count von Rosen in his archeological volume is Casabindo, about 140 kilometers northwest of Jujuy, a typical Andean locality. The description of discoveries here, at Morohuasi in the Quebrada del Toro, and at Tolomosa in the Tarija valley, reveals an interesting archeological situation: it is evident that there was anciently in this area a fairly high type of culture comprising such elements as urban life, urn burial, pottery making, weaving, the use of llamas as burden bearers, and skillful agriculture. The Incas, when their attention was drawn to this part of the world, thus found a solid basis upon which to rear the fabric of their own polity. In other words, they here encountered geographical conditions which were propitious to the growth of a culture of a type that they could easily adapt to their requirements and to their continued dominance thereover. It will be found, I think, that the border of the territory wherein such conditions prevail and the border of Incaic power are practically the same thing.

In South America, where writing and even systematic tradition were alike lacking in ancient times, pottery and textiles and other objects capable of serving as the vehicles of artistic expression are the chief and perhaps the only means we have for tracing the main outlines of the early inhabitants' history. Judged in the light of what we now know of early history in Peru, the finds from the Argentine sites visited by Count von Rosen fall into at least two chronological groups. The earlier group consists of pottery either not painted at all or else painted with very simple designs of a geometrical character, purely decorative, not at all representational in purpose. The later group of finds is made up of a smaller number of objects which have a decidedly Incaic character (Figs. 169, 176, 178). But Count von Rosen himself is extremely cautious in the matter of chronological considerations. He makes no serious effort to determine the comparative age of any of his finds. Indeed, his pronouncement on the middle of page 147 seems to imply that we still know nothing of Bolivian and Peruvian chronology. This lack of chronological material and the accompanying apparent ignorance on the author's part of work that has been done to establish the main chronological features of Andean prehistory constitute the chief defect of Count von Rosen's archeological volume.

The ethnological volume of this pair of associated works deals with the present dwellers in the Gran Chaco. The meaning of the term *chaco* has long been the subject of debate, but there can be little doubt but that the author is correct in saying that *chaco* comes from *chacu*, a Quechua word meaning "a hunt." At all events, this vast partially forested region is the home of various savage folk who live still under much the same conditions as their ancestors did centuries ago.

The natives of the Chaco have always been at once singularly backward and singularly tenacious of their own mode of life. They were formerly extremely bellicose in their attitude towards their neighbors, and their warlike spirit seems to be far from dead. The Incas never made any great headway among them, but their failure to do so is to be explained on geographical grounds rather than by the ferocity of the Chaco peoples—the inadaptability of a highland people to hot forested lowlands.

Today, as in the past, the two most important ethnic groups are the Choroti and the Chiriguanos. Our now intimate knowledge of Choroti customs is chiefly due to Baron Erland Nordenskiöld who, with the same self-dedication to science that distinguished the late Frank Hamilton Cushing, lived among the Choroti for some time.

The Choroti dwell in rough thatched huts, practice tattooing and artificial distention of the ear lobes, wear scanty clothing, are fearfully filthy about their persons, and live principally by hunting and fishing. In view of the importance to them of this last means of livelihood, their material culture is amazingly incomplete, for Count von Rosen tells us (p. 105) that they "have no water craft of any kind (not even rafts), but do their fishing swimming or wading." In this respect they show a curious lack of response to the possibilities of their environment, for the materials for water craft, or at any rate for rafts, are abundant around them. At best, the Choroti fisherman sits on a rickety platform in shallow water in which he fishes with a variety of nets and tackle that does much more credit to his intelligence than does his almost comic condition of boatlessness. It is well to note in passing that even the most advanced ancient people of America had only very primitive craft, hardly more than large rafts with sails, and that in this respect the Choroti were not far behind their more civilized kinsfolk.

The household furniture of the Choroti is primitive. Though he has coarse pottery, gourds and basketry are really more important to him. The fine arts, as exemplified by the decorations applied to utensils in daily use, are embryonic with the people.

The Chiriguanos are another great stock of like category with the Choroti.

They were in martial contact with the Inca empire at least as early as the reign of Pachacutec. In certain respects, their culture is superior to that of the Choroti; they have better huts, and they arrange them in a more orderly and regular fashion; their pottery is more varied in shape and better decorated; their chief means of livelihood is agriculture; and their fishing technique commands especial respect because of their cleverness in shooting the fish with small arrows and bows.

Very different from these woodland tribes are the *Gauchos* (generally speaking a mixed breed of white and Indian) of the plains, the cowboys of the Argentine, to whom and to whose picturesque customs Count von Rosen gives an interesting chapter.

The two books just reviewed are beautifully illustrated and printed and singularly free from typographical error—I have found but one misprint in the two volumes.

PHILIP AINSWORTH MEANS

GEOGRAPHY AND THE ROMAN EMPIRE AND ROMAN BRITAIN

M. P. CHARLESWORTH. **Trade-Routes and Commerce of the Roman Empire.** xx and 288 pp.; bibliogr., index. University Press, Cambridge, 1924. 12s. 6d. 7½ x 5 inches.

F. HAVERFIELD. **The Roman Occupation of Britain: Being Six Ford Lectures . . . Now Revised by George Macdonald, With a Notice of Haverfield's Life and a List of His Writings.** 304 pp.; maps, diagrs., ills., index. Clarendon Press, Oxford, 1924. $6.00. 9 x 6 inches.

Map of Roman Britain. Scale 16 miles to one inch. Ordnance Survey, Southampton, 1924. 4s.

Never before the dawn of modern times was the geographical horizon of Western civilization so broad as during the first two centuries of our era, at no other time did the forces of economic geography operate so nearly as they do at the present day. In the epoch of peace which lasted almost uninterruptedly from the reign of Augustus to that of Marcus Aurelius commerce flourished throughout the vast domains of Rome, and trade relations were maintained even with the Far East by overland and oversea routes to China and India. Charlesworth in a pleasantly written little volume attempts to review in turn "each province or region [of the known world at that time], discussing successively routes, agricultural resources, mineral wealth, industries, and the intercourse of different peoples within that province." In trying to carry out this enormous program he sweeps us from one subject to another a little too rapidly for comfort. Few pages, however, do not contain some meat for the geographically-minded reader, whether he be interested in the growth of man's knowledge of the earth's surface or in the nexus between human life and natural environment in the only genuine world empire that has ever approached success.

Professor Haverfield's postumously published lectures deal with a topic areally more limited, but with one which Haverfield had mastered both in its details and in its larger implications. Not only a learned archeologist and historian, Haverfield was a keen and accurate thinker, an unusually gifted writer, and, of even more importance to us, a geographer at heart. There are many sound lessons in human geography to be learned from the volume before us. One entire lecture, indeed, is devoted to the geography of Britain in relation to the Roman conquest, and a geographical thread runs through the entire work.

After the establishment of Roman control over Britain, two areas became evident, each with a distinctive type of occupation. The upland country to the north and west remained wild and more or less unsubdued. Roman occupation was here ex-

clusively military: troops were quartered in permanent forts of great strength (often miscalled "camps" in modern times) where the legionaries and auxiliaries served out their long terms of enlistment. The lowlands of the east and south, on the other hand, formed the settled regions. No troops were stationed there; the inhabitants were at peace; agriculture was the main industry, and the land was for the most part held by Romanized British nobles. The distinction between the turbulent frontier uplands with their army posts and rough life, and the tranquil, civilized lowlands with their farming population, is the central fact in the human geography of Roman Britain.

Within the settled regions, "the local distribution of the civilization was uneven" (p. 182). Certain parts of southern England were then "occupied by a population both numerous and wealthy and (as we may think) well educated. It is interesting to note, in passing, that most of these areas are still thickly peopled by other than urban inhabitants. The Thames valley from Oxford to Goring was probably the home of an abundant riverside population much less advanced in culture. You may see their traces, in any dry summer, in cornfields between Oxford and Radley or round Dorchester and Wallingford. The mud walls and ditches of their meagre farms have indeed vanished, but they have left damper soil along the lines they followed. Here in scorching heat the grain grows taller than around, and the circles and squares that thus arise raggedly above the general level are plain to any moderately observant eye" (p. 183). It is a pity that Haverfield could not have lived to see the use now being developed of airplane photography for the surveying of similar traces of former civilizations (see *Geogr. Rev.*, Vol. 13, 1923, p. 616, and *Ordnance Survey Professional Papers*, New Series, No. 7, 1924).

Haverfield warns us against an error not uncommon among earlier students of Roman archeology in Britain, the error of viewing Roman Britain as detached from the greater political and economic unit of which it formed but a small and relatively unimportant part. Haverfield himself exemplified the principle that the student of Roman Britain must be thoroughly familiar with the civilization of the Empire as a whole. His broad historical and archeological knowledge enabled him to see the province of Britain in its true perspective. "In Britain," he wrote, "Rome had passed beyond her proper limits. Rome was a Mediterranean Empire. Its politics, its civilization, its trade, its whole life, were based on that inland sea. The lands in which it wrought most successfully lay round its shores or at least within easy reach. Wherever the Empire stretched out its frontiers beyond those bounds, its work was imperfect. . . . Not because Britain is more than eight hundred miles from Rome, but because the Italian climate and sky and manner of life are wholly un-British, the Emperors of Rome had little business here. And now they have all gone like an insubstantial pageant faded, and from the Romans who once ruled in Britain, we Britons have inherited practically nothing. Here and there Roman roads still linger on in modern use. For the rest, the Roman has passed from Britain as though he had never been. He has left no name on hill or river; he has not even bequeathed a few drops of Roman blood. Racially, topographically, culturally, ancient Rome has nothing to do with modern Britain" (pp. 285–286).

Of course in this last sentence Haverfield refers to direct influence from the Roman occupation of the island. No one can deny the tremendous indirect influence of Rome upon the entire civilization of modern Europe.

The excellently clear map of Roman Britain published by the Ordnance Survey, shows the principal Roman remains in black against a hypsometrically tinted ground. A distinction is made between roads whose course is certain and those whose course is uncertain. The *municipium* of Verulamium and *coloniae*, towns, other civil sites, legionary fortresses, temporary and permanent forts (note that the word "camp" is not used), signal stations, and potteries are all indicated by different symbols.

Strabo's Description of the Troad

Walter Leaf, edit. **Strabo on the Troad, Book XIII, Chap. I, with Translation and Commentary.** xlviii and 352 pp.; maps, ills., index. University Press, Cambridge, 1923. $10. 9 x 6 inches.

This scholarly edition of Strabo's chapter dealing with the Troad supplements Dr. Leaf's volume entitled "Troy; A Study in Homeric Geography," London, 1912. The arrangement is similar to that of Sir James G. Frazer's well-known edition of Pausanias' "Description of Greece." After a geographical and historical introduction a critical version of the Greek text is given. The main portion of the book is made up of brief passages translated from the text, each followed by extensive commentary. The volume is liberally illustrated with photographs and sketch maps and is accompanied by a general map of the district. It represents the results of many years' research and of detailed personal knowledge of the ground.

The interior of the Troad peninsula was apparently once a plateau into which the streams have cut back their headwaters. These streams now pass out from the somewhat inhospitable uplands of the old plateau through a series of gorges. The highest elevation, Mt. Ida (5800 feet) in the southeastern part of the peninsula, sends forth toward the west a long ridge which reaches the Mediterranean coast and forms a remarkably well defined climatic frontier. North of this ridge we find the continental climate of southeastern Europe, with its cold winters and relatively abundant rainfall even in summer. The coastal plain of the Troad is here covered with "a scattered open forest, almost like a well-planted English park." South of the ridge, on the other hand, we are "in the midst of vegetation formed to resist the long and almost complete summer drought of the Mediterranean climate—the thorny, aromatic, glaucous *maquis* with the gums which enable it to conserve to the utmost the precious moisture against evaporation. The change is in itself a familiar one, but there can be few places where it can be followed so completely within so short a distance." The greater part of the coast of the Troad is lined by cliffs "formed of clayey or sandy marls . . . not indeed precipitous . . . but steep enough to form insurmountable obstacles to landing except at comparatively few points."

In the Homeric age, as now, the dividing ridge with the climatic frontier which runs along it tended to cut off the northern from the southern part of the Troad. The northern region in the Catalogue of the Trojans (Iliad II, 818 ff.) is "assigned to the kindred tribes of the Troes and Dardanoi, while the southern belongs to the tribes of the Leleges and Kilikes, combined under the name of Pelasgoi. Homer's Kingdom of Priam, with the adjacent Pelasgoi, forms a whole entirely consistent with geographical facts." The defensibility provided by the cliffs along the coast and the dominant position overlooking the Dardanelles unquestionably have been determining factors in the history of the Troad from the earliest period. "Since the days of Priam it has always been a pawn in the games played by great powers to the east and west. The history of the Troad is in fact only a part of the much more important history of the Strait of the Dardanelles."

In classical times the Troad was an object of sentimental and of scholarly interest. A rumor, which may have had some foundation, was spread abroad in Rome to the effect that Julius Caesar and, later, Augustus seriously contemplated moving the capital of the Empire to the site of Troy, Rome's traditional mother city. The extreme interest in Homeric geography which prevailed in the first century before Christ is revealed in the fact that Strabo devotes about one-quarter of the space which he gives to Asia Minor to his discussion of the Troad, although the whole area of the latter "may perhaps form about one-sixtieth" of that of the former. In spite, however, of the disproportionate space which Strabo gives to the historic peninsula, Dr. Leaf believes that he was not personally acquainted with it. There

are many surprising errors in his account, and his knowledge of contemporary conditions in the Troad is particularly wanting.

Orogenic Theory and the Case of the Alps

Leopold Kober. **Der Bau der Erde.** 324 pp.; maps, diagrs., ills., bibliogr. Gebrüder Borntraeger, Berlin, 1921. 10½ x 7 inches.

Leopold Kober. **Bau und Entstehung der Alpen.** 283 pp.; maps, diagrs., ills., bibliogr. Gebrüder Borntraeger, Berlin, 1923. 10 x 7 inches.

Eduard Suess, in his famous work "Das Antlitz der Erde," made the first serious attempt to solve the great riddle of earth structure by an inductive study of all known tectonic features. It is fitting that one of his successors in the University of Vienna should renew the attempt to fit the great mountain systems of the globe into a broad structural scheme. Going further than Suess in recognizing genetic relationships, Professor Kober, in "Der Bau der Erde," considers all of the Tertiary mountain chains in southern Eurasia and northern Africa as parts of a single great structural unit, or *orogen.* The trend lines of the Alps continue westward through the Pyrenees and the Betic Cordillera, eastward through the Carpathians, the Balkan arc, and the Caucasus. East of the Caspian Sea the line of chains is taken up in the border ranges of Turkestan, carried northward and eastward through the arcs bounding the Pamir plateau, continued through the Kunlun and deflected south into the chains along the Mekong, to end finally at the Gulf of Siam. In this line of mountains, reaching entirely across Eurasia, there is consistent overturning of the folds in the Alpine sense; that is generally northward over a foreland. The asymmetry of cross section considered by Suess to be the general characteristic of folded mountains is recognized in all members of this great unit.

But Kober extends the picture. A remarkable counterpart of the Alpine unit may be traced through the Atlas, the Apennines, the Dinaric Alps, the mountains of Greece and the Grecian Isles, into the ranges of Taurus and Iran. Other chains carry the same general trend to the great Himalayan arc, and in Burma there is a deflection southward, to connect with the line of mountains running through the Sunda arc to Timor. In these successive chains, from Morocco to the East Indies, there is consistent overturning of folds over a foreland to the south, directly away from the Alpine unit. But the mountains in this southern line are closely related to those in the northern, in kind and age of rocks, in kind and age of structure. This double zone of mountains, thousands of miles in length, hundreds of miles in width, is a typical *orogen,* or orogenic zone. In places the opposite border ranges are separated by wide areas, little deformed, called by Kober the "Zwischengebirge." Elsewhere this middle member has been squeezed out or overridden, and the border ranges stand back to back as in the Alps and Dinarides.

Naturally Kober seeks to find other examples of his *orogen* among the mountains of the past and present. The Caledonian structures of Scandinavia and Scotland conform admirably to his bilateral conception, and there is some evidence that *decken* reach both east and west in the Urals. In general the American mountains fit into the scheme only with considerable modification. Thus both the Appalachian and Andean systems appear to be dominantly unilateral, and in each case it is necessary to assume that one set of border chains, if it ever was developed, is now concealed by the ocean. Kober pairs the Rocky Mountains with the "Pacific ranges," the Great Basin and the Columbia plateaus occupying the position of the "Zwischengebirge." It is not clear whether the Sierra Nevada or the Coast Ranges have the eastward-dipping structures shown in Kober's diagram. Obviously the Sierra Nevada folding is much too old to be considered as contemporaneous with Rocky Mountain thrusting. On the other hand such eastward-dipping thrusts as

have been reported in the Coast Ranges appear to be considerably more recent than the westward-dipping thrusts of the Rockies. It seems, however, that Kober does not insist on strict agreement of time for his border ranges.

One feature in Kober's diagram of the North American *orogen* will doubtless arouse criticism, and yet it can now be defended. The Colorado plateau is represented as lying entirely east of the Rocky Mountains. Kober has surmised that the thrusts characteristic of the northern Rockies continue southward on the west side of the plateau, and recent field studies suggest that this is actually the case. Blackwelder has announced that the Willard thrust, in northern Utah, dips to the west. The reviewer considers it very probable that the Muddy Mountain and Spring Mountain thrusts of Nevada are of the same geologic date as the Willard, Bannock, and other Rocky Mountain thrust faults. Therefore Kober's contention that the southern Rockies ("pre-Cordillera") form a separate unit far to the east of the true Rocky Mountain axis will probably be sustained.

The principal cause of mountain deformation is ascribed by Kober to contraction of the earth. Great rigid segments of the crust are crowded together, crushing and underthrusting the sediments in bordering geosynclines. Thus the two-sided *orogens* are developed. Considerable assumption is used in extending mountain zones and geosynclines beneath the oceans in order to round out the structure map of the earth. It is not surprising that some of Kober's assumptions are open to criticism, for his is a pioneer book dealing with a very large subject. His theory is stimulating, and probably it will be given important consideration as the study of mountain structures develops.

"Bau und Entstehung der Alpen" is a valuable companion volume to "Der Bau der Erde." In a way, it is an exploitation of Kober's theory concerning orogeny, and the new book opens with a brief summary of this view as applied to the Eurasian mountains. There follows a general discussion of the significance of the *decken*, the great superimposed rock sheets that figure so prominently in Alpine structure. The body of the book is taken up with a description and explanation of significant structural features in the West Alps, the East Alps, and the Dinarides (Dinaric Alps). Significant stratigraphy is discussed in its relation to the tectonic history. The three principal *decken* of the Alps, known as the Helvetian, Pennine, and East Alpine, are described separately and in relation to each other, and various well-known features of the Alps are explained in terms of the *decken* structure. Cross sections through the Alps and Dinarides demonstrate a definite bilateral structure, with rock sheets (*decken*) reaching north and south from a line or cicatrice dividing the two mountain systems. According to Kober's interpretation, this structure is a special case of orogenic development and indicates extreme compression. The middle member of the orogenic zone ("Zwischengebirge") was either crowded out or forced into the depths, and the Dinaric border chains were in part thrust over the larger Alpine limb.

The paleogeography of late Paleozoic and of Mesozoic time is sketched in a chapter on the Alpine geosyncline, and the orogenic history is given in summary. Kober agrees with Heim that the *decken* were formed by recurrent movements starting in the upper Cretaceous and culminating in the Pliocene. The East Alpine sheet was formed first, then the Pennine, and finally the Helvetian (see Albert Heim: Geologie der Schweiz, Leipzig, 1919, 1922). This general order of development is the reverse of that deduced in earlier studies.

Vertical movements have occurred in late geologic time. A study of gravity data indicates a large degree of isostatic compensation for the Alpine mass, but there are many problems in connection with isostasy yet to be solved. "The Alps still hold many riddles."

Quite aside from the development of his theory of mountain making, Kober's book is of value as a concise and up-to-date treatise on Alpine structure. English

readers are especially indebted to the author for a clearness and directness of style rarely equaled in German scientific works. A useful tectonic map of the Alps, on a scale of 1: 1,500,000, is a further aid in elucidating Kober's discussion.

CHESTER R. LONGWELL

The Japanese Earthquake of September, 1923

A. Imamura. **Preliminary Note on the Great Earthquake of S. E. Japan on Sept. 1, 1923.** 22 pp.; map, diagrs. *Imperial Earthquake Investigation Committee, Seismological Notes No. 6,* Tokyo, 1924.

K. Suda. **On the Great Japanese Earthquake of September 1st, 1923.** 6 and pp. 137–239 and 1–49; maps, diagrs., ills. *Memoirs Imperial Marine Observatory,* Kobe, Japan, Vol. 1, 1924, No. 4.

Professor Imamura was in the Seismological Institute in Tokyo when the shock occurred. At first it was rather slow and feeble but increased rapidly and reached its greatest strength in 16 or 17 seconds. All the seismographs in the Institute recorded the beginning of the shock, but all except the EW component of one instrument, magnifying twice, were quickly thrown out of adjustment. Within five minutes, however, Professor Imamura had several large motion instruments again recording. The first movement was towards the NNE and upwards, and from the length of the first phase he was able immediately to say that the origin was in Sagami Bay to the south. The instruments recorded several waves with a period of 1.35 seconds and a range of earth movement of nearly 9 centimeters. Professor Imamura thinks that later waves with a period two or three times as long and with a range of about 20 centimeters may have occurred. He says that this earthquake was by no means the strongest ever felt in Tokyo but was by far the most disastrous; and he estimates that 95 per cent of the damage in Tokyo was due to the fire. He gives descriptions of other effects of the earthquake, but Professor Suda's account is fuller and will be followed in this note.

Sagami Bay, where the shock had origin, is a body of water of semicircular shape about 70 kilometers in diameter opening to the south into the Pacific. The island of Oshima lies at its mouth; the volcano on the island was very active a few years ago but has been quiet for some time and was not affected by the earthquake—which shows pretty clearly that the earthquake was purely tectonic. The peninsula of Boso forms the eastern boundary of the bay, and that of Izu the western. The peninsula of Miura projects a short distance into the bay on the northeast and separates it from the narrower Bay of Tokyo. At the time of the earthquake striking changes of altitude occurred all around the bay. The greatest elevations occurred along a zone running west-northwest from the southern part of Boso peninsula. On both sides of this zone the elevations diminished, and in the southern part of Izu peninsula and the island of Oshima there was a small depression of 30 centimeters. At several stations elevations of 3 to 4 meters were recorded, and at the end of Miura peninsula the elevation amounted to 7.60 meters; but, strangely enough, these elevations decreased slowly after the shock and in less than a month were reduced to less than half. The tide gauge at the end of Miura peninsula showed that the land there had suffered a slight depression extending over several years preceding the earthquake. The most remarkable of all the changes were those in the depth of the bay itself. It is very deep, ranging from 800 to 1400 fathoms over much of its extent. Soundings were made about ten years ago and were repeated with much care after the earthquake, showing differences of from 100 to 400 fathoms, in some places of elevation and in others of depression. It seems incredible that such astounding movements could have occurred at the time of the earthquake, especially as the water wave set up was not more than two or three meters high except where

it was increased by the configuration of the shore. But Professor Suda defends the observations, and we shall have to await the full report (see also the remarks of Dr. Charles Davison in his paper "The Japanese Earthquake of 1 September, 1923," *Geogr. Journ.*, Vol. 65, 1925, pp. 41–61). The thorough study of the earth's movements accompanying the earthquake may throw light on the mechanism of earthquakes; from this point of view it is unfortunate that the epicentral region was under the sea; but from the humanitarian point of view it is fortunate. No great faults were formed on the land, though they must have been formed under the bay. The phenomena generally were similar to those observed in other earthquakes. Much property was destroyed and many lives lost, for which several causes are invoked: the actual vibrations of the earth, fires starting by collapsed buildings, landslides on the steep slopes, and the sea waves on the shore, which in places rose 10 or 12 meters.

Professor Suda discusses many phenomena, the influence of the geology, the changes in springs and wells before and after the earthquake, the preparatory shocks, the aftershocks, meteorological influences, etc. He makes many interesting suggestions but seems to carry some of his theoretical discussions too far. When the full report of this earthquake is published it will furnish seismologists with abundant material for many studies.

Harry Fielding Reid

A Popular Treatise on Meteorology

C. F. Talman. **Meteorology: The Science of the Atmosphere.** 384 pp.; maps, diagrs., ills., glossary. (Popular Science Library, Vol. 1.) P. F. Collier & Son Co., New York, 1922. 8 x 5½ inches.

This is Volume 1 in a Popular Science Library to consist of sixteen volumes with a history of science, glossaries, and a general index. No index is given with the present volume, the plan of the editorial board being presumably to meet this need in the general index. It will be interesting to note how this plan succeeds.

Professor Talman in his capacity as Librarian at the Chief Office of the Weather Bureau in Washington has had access to much material and information and has with care and precision selected what seemed appropriate for a work of this kind. The book is carefully written and is all that a popular treatise in the best sense should be. It would perhaps have been better if Professor Talman had come out boldly and called his book "Aerology". He slips slightly in trying to limit the word "aerology" to exploration of the atmosphere by means of kites and balloons. This may be the definition adopted in denoting the character of work of some special division in the Weather Bureau; but one might as well limit geology and hydrology to surface strata of the earth and surface currents in the ocean. Moreover, in the glossary, under aerology, it is stated that "aerological investigations . . . also include observations of clouds, meteor trails, the aurora, etc." And, of course, kites and balloons have hardly reached the levels of meteor trails and auroras.

There are some slips, too, in connection with the reference to the discovery of the stratosphere. We are told that the rate of temperature decrease averages about "1 degree Fahrenheit per 300 feet." This is not the rate in the free air. And again, "a sounding balloon sent up from Batavia, Java, in November, 1913, recorded 113° below zero Fahr., the lowest air temperature ever observed." The record for this particular ascent (November 5, 1913) is —91.9°C. somewhere near 17,330 meters. If we must give it in Fahrenheit the reading is —133°. This illustrates the difficulty of doing business with the Fahrenheit scale in the upper air. Unfortunately there are no tables of conversion given; indeed the book is free from tables, which may or may not be an advantage.

In the last chapter of the book, Atmospheric Byways, there is reference to "the year without a summer", that is the summer of 1816. Blodget, Perley and Charles Peirce are quoted, and it is stated that "there was scarcely a vegetable came to perfection north and east of the Potomac." The Monthly Weather Review is quoted as citing the recollections of James Winchester of Vermont. "*It is said* (italics ours) that in June of that year snow fell to the depth of three inches in New York, Pennsylvania, and New Jersey on the 17th; five inches in all the New England States. . . . The year 1816 had neither spring, summer, nor autumn." Now this seemed a rather extravagant statement; and the reviewer, having access to reliable records, finds that while corn was killed by frosts on September 28, 1816, the year does not deserve the sweeping condemnation given. April was mild with little snow; May cold and backward; June warm but with a frost on the 10th; July cool and dry; August warm; September unsettled with frost on the 28th, which killed corn; October mild and pleasant; November cool; and December warm with little frost.

Regarding the severe frost of September, I find in the Rodman records made at New Bedford, "September 26, 27, 28, frost which killed the corn and vines in some sections and injured them in many places. The temperature at sunrise, 27th 38°F.; 28th 37°F.; 29th 38°F.; 30th 48°F." The rainfall at this place for 1816 was 44 inches (the normal is 46 inches); the annual temperature, 46°F. (the normal is 48°F.). It appears to be a case of giving the dog a bad name.

Professor Talman has done a good service to the public in preparing this volume. He presents much information in clear and simple terms; and the book can be heartily recommended to those who care to know about the atmosphere but feel barred because they cannot comprehend the mathematical discussions with which so many scientific books are loaded.

Alexander McAdie

Dune Studies

Ivar Högbom. **Ancient Inland Dunes of Northern and Middle Europe.** Maps, diagr., ills., bibliogr. *Geogr. Annaler*, Vol. 5, 1923, No. 2–3, pp. 113–243.

Michel St. Jonesco-Balea. **Les dunes de l'Olténie.** Maps, diagrs., ills., bibliogr. *Rev. de Géogr. Annuelle*, Vol. 11, 1923, No. 2, pp. 1–126.

Our knowledge of the postglacial climatic development in northern Europe is founded mainly on examination of peat bogs and investigations of plant geography, and these have rarely been wholly satisfactory. The author of the first paper listed above endeavors, by researches on dune formation, to solve many of these perplexing problems, and the chief value of his paper lies in investigations of this kind.

Mr. Högbom's studies began at home with an investigation of the Swedish dunes; but he soon found that these were rather easily disposed of and then extended his investigations over the German and Hungarian dune districts. From these field studies of his own and a critical examination of much (though not all) available "original sources," he has tried to produce a survey of the entire dune problem of northern and middle Europe. Students of the subject are to be congratulated on the measure of success that he has attained.

In Chapter I, entitled "Dune-formation and Dune-morphology," he has undertaken to treat the many theories regarding dune formation and the mechanics of dune drifting, rightly considering that these are not unimportant to the comprehension of ancient dunes. In this chapter he considers such subjects as dunes and wave movement, the theory of ripple marks as embryonic dunes (in which he makes a mathematical analysis of the unstable pressure conditions on a sand surface), the theory of small obstacles, and the shield-formed or the laterally extended sand accumulations as initial dunes; and he also devotes considerable space to a dis-

cussion of dune profiles and the basal forms of dunes. This is followed by a study of the influence of alternating winds, secondary dune forms, characteristics and forms of the dune fields, and, lastly, the composition and form of the dune sands.

Another chapter deals with the ancient dunes of Fenno-Scandia and Denmark, the dunes of middle Sweden, dunes in northern Sweden, dunes south of the Baltic, dunes in Germany and in Poland, and with the Hungarian dune fields (the field of Cholnoky's studies). Some climatological conclusions are grouped in the fourth, the final chapter, in which the author enters a field that has been the arena of the hottest discussions among the geologists of Scandinavia; and he was wise to look beyond the borders of his own land for a solution of the problems arising there.

The broad area considered and the carefulness of the personal observations make Mr. Högbom's paper a most interesting and valuable contribution to the dune problem.

M. St. Jonesco-Balea's monograph is an attractive regional study. Part I presents a general survey of the physical characteristics of Oltenia, the western portion of the Rumanian region of Wallachia, as they have bearing on the question of the dunes. The second part considers the dunes. In Chapter I the author enters upon a study of the genesis of the dunes, considering in detail the causes and processes of their formation, with an account of the evolution of the Carpathians, whose erosion has furnished the materials for the making of the dunes. The geological history of the Carpathians is correlated with the growth of the dunes, the relief of the older dunes differing in its features from the dunes now forming. Chapter II takes up distribution and morphology; Chapter III lithology. Biogeography, as treated in Chapter IV, and the economic possibilities in Chapter V are especially interesting. The dunes steadily advance before the prevailing winds (the west wind of summer is the great dune builder). However, the dunes are not a "fatal consequence of climate," as the fact of ready consolidation proves. It is easy to fix the ascending slope with any herbaceous plants having good roots. A regional vegetative cover has been largely removed by imprudent cutting of such forests as formerly existed and the pasturing of pigs and of sheep, whose hoofs cut into and loosen the sand. In the work of replanting, the locust (*Robinia pseudacacia*) has been a factor of first importance. It is vigorous, demands little, prefers light and sandy soil, has long and powerful roots which reach the water at great depths, and increases the nitrogen content of the soil. This tree grows rapidly and covers more and more infertile soil. Aside from the economic value of the wood and its improvement of the soil, it has a marked effect upon the climate, as is more and more apparent every year, especially in the conservation of moisture. In 1852 the Rumanian government began planting with this tree, but one-half of the dune area of southern Oltenia is not yet planted. Most of the land that has been given to agriculture here deteriorates rapidly. The author of the paper suggests an alternation of generations between agriculture and forests for the formation of humus so readily exhausted. Improving the forest cover would cause the swamps to dry up, helping sanitation in the district; and finally the strategic value of reforestation would well repay the cost, for this dune country is on the frontier.

Collier Cobb

International Rivers

J. P. Chamberlain. **The Régime of the International Rivers: Danube and Rhine.** 317 pp.; bibliogr. (Columbia Univ., Studies in Hist., Econ., and Public Law, Vol. 105, No. 1.) New York, 1923. $3.50. 9 x 6 inches.

The author tells us in the preface that this study was undertaken "from the standpoint of the lawyer, not of the economist or historian, as an effort to explain international law and international organization in process of development" (p. 5).

The reader will find, however, that the emphasis is chiefly upon historical development, with relatively less attention to international organization and little attention to international law.

The thesis is divided about equally between the Danube and the Rhine, Parts I and II respectively. In each part the author begins with a brief statement as to river geography; following this there is a bit of political history; and thereafter he proceeds with a rather detailed narrative of the development of the international régime. An analysis of important river treaties and two documents relating to the Danube are printed as appendixes. The bibliography of 86 titles is sufficiently varied to include the *Sachsenspiegel* and an issue of the *New York Evening Post* but omits, unfortunately, Kaeckenbeeck's "International Rivers" (1918) and Ogilvie's "International Waterways" (1920). Possibly Dr. Chamberlain's thesis was finished before these earlier monographs appeared, although his bibliography does include such recent titles as Sayre's "International Administration" (1919) and Hajnal's "The Danube" (1920). There is no index.

The study is presented in a style which proves wearisome, and the text is too often overburdened with detail. A little more discrimination in sifting out the spade work and separating it from essential materials would have contributed to make a more effective monograph. The author indulges in few generalizations and those indulged in are not always relevant. For examples of the latter, see pages 76–77 (the unanimity rule), 209–210 (derogations from sovereignty), and 275 (the laws of war on land). A number of typographical errors could have been eliminated by more careful proof reading.

If geography has largely determined the routes of trade and travel, it is the conflict of interests with respect to trade and travel that has given rise to some of the most difficult of international problems. Contemporary interest in the more fundamental aspects of these problems is a healthful sign. While it can hardly be said that Dr. Chamberlain has made new discoveries with respect to the régime of international rivers, his narrative of developments should prove a useful addition to the literature of this important subject.

Edwin D. Dickinson

CORRESPONDENCE

Work in Oceanography

A letter from Dr. Jules de Schokalsky, dated Leningrad, May 5, 1925, informs the Society that he is at work on an English translation of his "Okeanografia," reviewed by Professor Camena d'Almeida in the *Geographical Review*, Vol. 14, 1924, pp. 679–680. Dr. Schokalsky expresses his appreciation of the review, which has proved "very useful in the writing of the new book" but would call attention to two instances of "undue criticism." While omitting the name of Dinklage his theory of "Auftriebwasser" is referred to in three places, pp. 130, 133, 136. A map showing "the variations of the temperature of the surface of the seas such as Murray and Schott have given" is included, Fig. 53, pp. 130–131.

General A. W. Greely, Honorary Member of the Society, has received a further communication from Dr. Schokalsky describing some of the geographical work done in Russia in 1924. Reference is made to the Kozlov expedition (see *Geogr. Rev.*, for April, 1925, p. 323), the leader of which has again returned to the field, and the Soviet government's expedition to Wrangel Island. In addition to hoisting the S. S. S. R. flag at Rodgers Harbor, part of the southeastern coast of the island was surveyed, and oceanographical investigations were carried out. Dr. Schokalsky himself organized an oceanographical expedition to the Black Sea. A convenient

steamer was put at his disposal by the Hydrographic Office of the Navy and a scientific staff of seven men—oceanographers, chemists, and biologists. Investigations were conducted in June and July in the eastern half of the Sea from the Crimea to Batum and Tuapse, the usual observations being made at 27 deep-water stations. During the autumn and winter supplementary cruises were performed, and in February of this year the same cross section from the Crimea to Batum was studied. This will afford material for the study of conditions the whole year round. Results are now being worked up, and it is hoped that further observations can be made during the summer.

Colonel Fawcett's Explorations in Central Brazil

The Society is in receipt of a letter from Colonel P. H. Fawcett dated March 10, 1925, giving further details of his proposed explorations in central Brazil. Colonel Fawcett wrote from Cuyabá, Matto Grosso, and reported that he had arrived there with his equipment intact and all plans completed for his journey through the unknown country between the Xingú and the Tapajoz, a plan which is to occupy the party during the rest of 1925 and most if not all of 1926. He expects to study the so-called "pit-dwelling" Indians known as the Morcegos or Tatus. They are an extremely primitive type of human being, inhabiting territory through which Colonel Fawcett must pass to reach his principal objective, namely, the unexplored country southeast of the Tapajoz, in latitude 8° and 9°, where he will run a line of traverse and make local topographic surveys. In the region are certain unvisited tribes and a culture that appears to be quite distinctive, with elements unknown in other parts of South America.

THE
GEOGRAPHICAL REVIEW

VOL. XV OCTOBER, 1925 No. 4

THE DANISH ETHNOGRAPHIC AND GEOGRAPHIC EXPEDITION TO ARCTIC AMERICA

PRELIMINARY REPORT OF THE FIFTH THULE EXPEDITION*

By KNUD RASMUSSEN

WITH THE COLLABORATION OF HIS ASSOCIATES

[With separate map, Pl. IV, facing p. 562]

Study of the Eskimos is a natural problem for Denmark. We have now for over two hundred years held the fate of the Eskimos of Western Greenland in our hand,[1] and the opinion of the civilized world regarding Eskimo civilization has to a great extent been based upon the literary and scientific works of Danes. The classics of the eighteenth century in this field are nearly all Danish. The first detailed description of an Eskimo tribe is the well-known account of Hans Egede, and few have succeeded in entering into the spirit and thought of the Eskimos to such a degree as did his son Paul.[2]

In Glahn's Diaries and Dalager's "Relationer" there is invaluable material on the Greenlanders of the eighteenth century while the descriptions of hunting equipment and methods by Otho Fabricius are so detailed and accurate that modern ethnography cannot better them.[3] In the nineteenth century the foundations for scientific study of the Eskimo were laid down by Rink, who was the first to make a systematic collection of Eskimo

*For translation of the larger part of the manuscript from the Danish the Society is indebted to Miss Elinor Bech of the Consulate General of Denmark, New York.

[1] The whole of Greenland was proclaimed a Danish colony in 1921.

[2] Hans Egede: Det gamle Grønlands nye Perlustration eller Naturelhistorie, Copenhagen, 1729 and 1741. English transl., "A Description of Greenland," London, 1745.

Paul Egede: Efterretningen om Grønland, Copenhagen, 1788.

Niels Egede, a brother of the latter, also published an interesting journal of his Greenlandic experiences.

[3] H. C. Glahn's Dagbøger (Det grønlandske Selskabs Skrifter Vol. 5, Copenhagen, 1921).

Lars Dalager: Grønlandske Relationer, Copenhagen, 1752.

Otho Fabricius, in *Kongelige Danske Videnskabernes Selskabs Skrivter*, Copenhagen, Vol. 5, 1810, and Vol. 6, 1818.

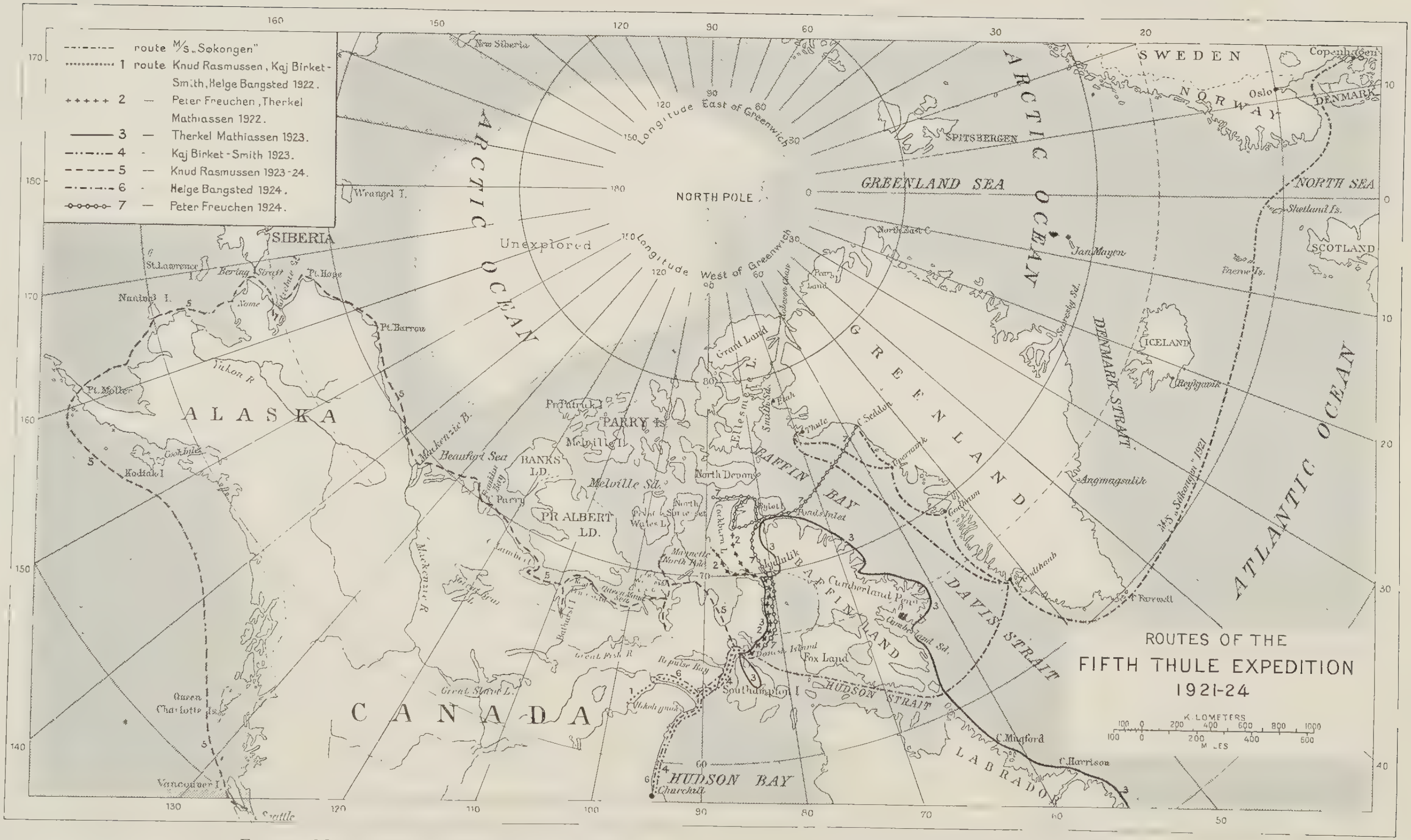

FIG. 1—Map showing the routes of the Fifth Thule Expedition, 1921–1924. Scale approximately 1:42,500,000.

legends and also the first to undertake comparative investigations into the origin and development of the Eskimos.[4]

Gustav Holm has given a description of the hitherto unknown civilization of the Eskimos of Angmagssalik on the east coast of Greenland in a volume which is universally acknowledged a model ethnographic monograph.[5] William Thalbitzer is the first who has made use of modern, phonetic methods in studying the language of the Eskimos.[6] The late Professor Steensby has made geographic investigations on the adjustment of the various types of Eskimo civilization to natural conditions. His work led up to the hypothesis regarding the origin of Eskimo civilization which may be said to be the foundation of this expedition.[7]

The Eskimos Outside Greenland

The Eskimos, however, also occupy a vast territory outside of Greenland, including the long stretch of Arctic coasts from Davis Strait to the Pacific Ocean. Here a number of American and British travelers and explorers have taken up the problem. We meet here all the great names from the days of the Northwest expeditions: Ross, Franklin, Back, Dease and Simpson, Rae, M'Clintock, M'Clure, Collinson, and in our day the Norwegian explorer Amundsen. Probably none of these travelers gave particular attention to the inhabitants of the country, but there exist valuable observations from all of them. I wish, however, to lay particular stress on a few travelers from the district around our headquarters, in particular Parry and Lyon. The work of these two British naval officers is distinguished by an accurateness and a wealth of observation which is highly appreciated by one who has traveled in the same sections.[8] Furthermore, mention should be made of two Americans; namely, Schwatka, who was the leader of the American Geographical Society's first Arctic expedition and who first mentions the peculiar inland tribes of the Barren Grounds; and Charles F. Hall, whose maps of Melville Peninsula do not seem to be sufficiently appreciated.[9]

The most valuable ethnographic material on the Eskimos outside of Greenland is found in a series of monographs proceeding from the Bureau of Ethnology in Washington and the American Museum of Natural History

[4] Henrik Rink: Eskimoiske Eventyr og Sagn, 2 vols., Copenhagen, 1866 and 1871; *idem:* The Eskimo Tribes, *Meddelelser om Grønland*, Vol. 11, 1893.

[5] Gustav Holm: Ethnologisk Skizze af Angmagsalikerne, pp. 43–182 in Den østgrønlandske Expedition udført i Aarene 1883–85, *Meddelelser om Grønland*, Vol. 10, 1888; English transl., *ibid.*, Vol. 39, 1914, pp. 3–147.

[6] William Thalbitzer: A Phonetical Study of the Eskimo Language, *Meddelelser om Grønland*, Vol. 31, 1904.

[7] H. P. Steensby: Om Eskimokulturens Oprindelse, Copenhagen, 1905; revised English transl. in *Meddelelser om Grønland*, Vol. 53, 1916.

[8] W. E. Parry: Journal of a Second Voyage for the Discovery of a North-West Passage . . . in the Years 1821–22–23, London, 1824.

G. F. Lyon: Private Journal, London, 1824.

[9] W. H. Gilder: Schwatka's Search, New York, 1881. A short account of Schwatka's expedition appears in the "Arctic Meeting for the Reception of Lieut. Schwatka and His Associates of the Franklin Search Party of 1878–'79–'80," *Journ. Amer. Geogr. Soc.*, Vol. 12, 1880, pp. 237–274.

J. E. Nourse, edit.: Narrative of the Second Arctic Expedition Made by Charles F. Hall . . . During the Years 1864–'69, U. S. Naval Observatory, Washington, 1879.

in New York. Here may be mentioned the writings of Turner on Ungava Bay, of Murdoch on Point Barrow, and of Nelson on Bering Strait,[10] but above all the writings of Franz Boas.[11] Mention too should be made of his organization of the Jesup North Pacific Expedition, the object of which was to study the relationship between the civilization of northeastern Asia and of North America. Finally it must not be forgotten that latterly Canada has also taken an active part in the work by sending out the Canadian Arctic Expedition under the leadership of Vilhjalmur Stefansson. The writings of Stefansson himself as well as the descriptions of the Copper Eskimos by Jenness are of importance in Eskimo literature.[12]

Organization of the Fifth Thule Expedition

There were, however, problems enough left, and, wishful to contribute toward their solution and also to bring Danish ethnographical study into closer contact with American and Canadian science, the Fifth Thule Expedition was organized under the aegis of His Majesty the King of Denmark and at the expense of the Danish Government and the trading station of Thule.[13]

The Expedition started in the summer of 1921 on board the "Søkongen" commanded by Captain Peder M. Pedersen.[14] The members were: Peter Freuchen, cartographer and zoölogist, Therkel Mathiassen, archeologist and cartographer, Kaj Birket-Smith, ethnographer and geographer, Helge Bangsted, scientific assistant, Jacob Olsen, Greenlandic secretary and interpreter, and the leader, Knud Rasmussen, ethnographer and specialist in folklore. There were also six Cape York Eskimos, three of them women, whose special work was to free our time for scientific investigation by hunting and sewing, important matters in the Arctic sections. These Cape Yorkers gave splendid help and answered our expectations in every way. Leo Hansen later joined us on Kent Peninsula in 1923 as special moving picture photographer for the Expedition.

The objects of the Expedition were many and various, but the main purpose was a study of the Eskimos outside of Greenland from the standpoint of anthropology, archeology, ethnography, and especially folklore.

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[10] John Murdoch: Ethnological Results of the Point Barrow Expedition, 9th Ann. Rept. Bur. of Amer. Ethnology for 1887–1888, pp. 3–441.

Lucien M. Turner: Ethnology of the Ungava District, Hudson Bay Territory, *ibid.*, 11th Ann. Rept. for 1889 1890, pp. 159–350.

Edward William Nelson: The Eskimo About Bering Strait, *ibid.*, 18th Ann. Rept. for 1896–1897, Part I, pp. 1–518.

[11] Franz Boas: The Central Eskimo, 6th Ann. Rept. Bur. of Amer. Ethnology for 1884–1885, pp. 399–669; *idem:* The Eskimo of Baffin Land and Hudson Bay, *Bull. Amer. Museum of Nat. Hist.*, Vol. 15, 1901–07.

[12] Vilhjalmur Stefansson: The Stefansson-Anderson Arctic Expedition of the American Museum: Preliminary Ethnological Report, *Anthropol. Papers Amer. Museum of Nat. Hist.*, Vol. 14, 1914, Part II; *idem:* My Life with the Eskimo, New York and London, 1913.

D. Jenness: The Life of the Copper Eskimos, *Rept. Canadian Arctic Expedition, 1913–18;* Vol. 12, Ottawa, 1922.

[13] Thule Station in North Star Bay was established by Rasmussen in 1910 for service to the Eskimos of this northerly region and as a base for Danish exploration. See Rasmussen's account of the Thule District in the Bicentennial Volume, *Meddelelser om Grønland*, Vol. 60, 1921.—Edit. Note.

[14] The Committee for the Expedition consisted of M. Ib Nyeboe (Chairman), C. Erichsen, Major J. P. Koch, Professors O. B. Bøggild, A. Jensen, and C. Ostenfeld and Museum Inspector T. Thomsen.

In addition mapping was of particular importance because a great part of the country through which we traveled was either entirely unknown or very inadequately mapped. A preliminary map showing the territory covered is given in Plate IV, facing p. 562: it includes northern Baffin Land, Melville Peninsula, and Southampton Island. Our program also included regular meteorological observations at headquarters and on our trips, and geological, zoölogical, and botanical collections and observations. The working up of the vast body of scientific data acquired will take long, but it is now possible to give an outline of the results and an indication of their quality. This is done in the following sections written by the several members of the expedition.

FIG. 2—Arnarulunguaq, Little Woman, the only Eskimo woman who has ever visited all the tribes of her own race. She made the whole journey from Greenland through the Northwest Passage to Alaska with the Fifth Thule Expedition.

FOLKLORE

By Knud Rasmussen

Very little has heretofore been known of the social culture of the Eskimos outside of Greenland; and, furthermore, all explorers in this field have lacked the advantage given by an intimate knowledge of the Eskimo language. The study demanded that we should come in contact with as many tribes as possible, and it was primarily with this purpose in view that I undertook the long journey west to the Siberian coast (see Fig. 1).[15]

I shall here confine myself to a single aspect of the social culture which may seem a trifle specialized but which I have chosen because in a general way it shows the relationship which exists between all Eskimos from Greenland to Alaska. This is the belief that forms the basis of their entire view of life, as expressed through the mystical power *Sila* and the use of amulets.

[15] The wealth of material obtained includes data on the Aivilik and Iglulik and Barren Ground Eskimos; material for monographs on the Netsilik Eskimos between Bellot Strait and Adelaide Peninsula, and on the Umingmagtormiut (the people of the musk oxen), northeast of the mouth of Bathurst Inlet; information from the tribes between Coronation Gulf and Victoria Land; comparatively complete data on old hunting traditions and folklore from the original inhabitants of the region between Bailey Island and the Mackenzie Delta and from the Alaskan Eskimos, especially the former inland inhabitants between Colville River and Kotzebue Sound; general information on the Eskimos in Bering Strait and about East Cape, and descriptions of specially characteristic ceremonies on Nunivak Island.

The Power Sila

It is difficult to define Sila, difficult even to translate the word because we lack the basal conceptions. However, we may say that it has a threefold significance—the universe, the weather, and an expression compounded of common sense, intelligence, and wisdom.

Let us take by way of explanation and illustration the beliefs held by the Caribou Eskimos on the Barren Grounds. Here the word Sila (hila) is

FIG. 3—Miteq (Eiderduck) returns from a successful caribou hunt. He also accompanied Rasmussen on the long western journey.

used for a power personified by Hilap-inua or pinga, a woman. She is regarded not so much in the light of a creator of human beings or game as feared as a strict housekeeper, in particular with regard to the way in which game is treated. She is present everywhere and makes herself known when there is reason for her interference. The daily food must be treated with respect. When a caribou is killed, certain ceremonies must be observed to show honor to the killed animal, and at the same time everything which is not taken must be carefully covered. Sila must not see anything wasted.

The taboo system of the Caribou Eskimos is not as complicated and varied as that of the coast dwellers, but it is interesting to us in this connection because all taboo is in reference to Sila. Although the conditions Sila makes for man cannot be said to be difficult, she punishes their transgression with a terrible, powerful force—she sends bad weather or sickness, drives away the game from the hunting grounds—in fact, all those catastrophes which are most feared. Simple as is the basal thought the whole relation shows an unconscious wisdom which can only command our respect.

Sila has also another and different function, which I will illustrate by an experience on leaving my camp at Hikuligjuaq at an unfortunate time of

year, the spring breakup when as a rule no one travels. As an expression of the friendliness of the settlement toward the Expedition it was planned that one of their most important conjurors should get into touch with his helping spirits to smooth the way for me. As many people as possible were collected in a large tent; when the seance started I was requested to go outside and sit down in the snow where there were no footmarks. As the conjuror explained, I had to do this: *hilap takuniarmatit, hilap isiginiarmatit*,

FIG. 4—One of the dog teams of the expedition, which made the whole sledge journey from 1921 to 1924.

Sila must see me while the conjuror did what he could to rid my path of obstacles.

On this occasion I came face to face with an entirely new function of Sila, the good Sila, who was called in to help one who could not help himself. Otherwise the supernatural powers are only considered revengeful and all the religious endeavors of man are for the purpose of keeping them at a distance.

Nuliajuk of the Coast

It may here be remarked that among the coast dwellers the personification of Hilap-inua has become Nuliajuk, the woman, who, as mother of the sea animals and ruler over man's game lives on the bottom of the ocean. She is kept at a distance through an extraordinarily complicated taboo system. They seek to neutralize her powers for those sides of Sila which speak through the weather and which are man's greatest fear on earth.

Through all the Eskimo tribes the legend regarding Nuliajuk is the same and tells of a young orphan girl who was thrown into the ocean and since in some mystic way has settled on the bottom. The various smaller and

larger varieties of seal were created from the joints of her fingers which were chopped off her hands when she tried to hold on to the kayaks.

I questioned an old Netsilik Eskimo who narrated the legend:

"What existed before Nuliajuk?"

To this he answered very logically: "No taboo, but also there was no game."

"Then what did man live on?"

He answered: "The first men lived on earth. When they pitched camp and took over new land, they always started to dig in the ground where they looked for food."

"But where did they get blubber for their lamps?"

"At that time *aqerdlorqaq*, new drifts after a snow fall, might light up, but out under the open sky there was always black darkness; there was no light in the world."

The Conjuror of Nunivak Island

I could take the reader from settlement to settlement, not only from Hudson Bay but through the entire Northwest Passage to Alaska and everywhere find parallels to what have been described. Similar parallels exist for Greenland if we go back to the time before Christianity was known.[16] It would take too long to follow this thought out so I shall content myself here by going to Nunivak Island northwest of Kuskokwim Bay where the inhabitants are still entirely primitive and up to the last two years had not been influenced at all from outside.

Here I met an unusually intelligent conjuror by the name of Najagneq with whom I had a long discussion on the higher problems of life. He told me that his faith was concentrated on a strong spirit, Slam-jua, so powerful that he did not speak to man through ordinary words but through storms, snow, rain, the unrest of the ocean—through all the forces which man fears. This is Slam-jua's ordinary means of communication. But he also has another way of expressing himself—through the very young. Najagneq emphasized very strongly this contrast in the medium of expression—the unpent wildness of the weather, the innocence of a child. The children hear a small and careful voice, something like a woman's; they hear mysteriously, but so friendly and loving is the voice that they are not afraid. It says: *Sila ersinarsinivdlugo*, "danger threatens from the Universe." The children understand and tell it as if accidentally when they come home, without having any idea of its serious meaning. Then the conjurors take measures to prevent the impending catastrophe.

During good times Slam-jua has no message for man. He has disappeared in unending Nothing and stays away as long as man does not misuse the game, i.e. waste food or throw it in places which are not worthy of the holy meat. Slam-jua is never seen, and his habitation is mysterious. At the same time that he is with us he is also unendingly far away.

[16] K. Birket-Smith: Ethnography of the Egedesminde District, *Meddelelser om Grønland*, Vol. 66, 1924.

Fig. 5

Fig. 6

Figs. 5 and 6—In spring the expedition lived in tents, but in winter they built snow huts. Figure 5 is on Melville Peninsula. Figure 6 is not far from Baillie Island east of the Mackenzie delta; in the background high rough ice.

The mediators between the Universe and the mysterious forces of life are of course Angakut, the conjurors. I have a great deal of material regarding them and their functions, a splendid source of information for understanding the Eskimo psychology. I will merely touch on it here.

The Making of a Conjuror

It rarely happens that a person becomes a conjuror by his own choice. It is Sila that comes to him (or her) making him her vehicle for the benefit of his fellow man. Though the main principle in all conjuring and the relation of the conjurors to the supernatural is the same among all Eskimos, there are extremely numerous variations in the method by which the spiritual connection is achieved.

I found the most primitive form of conjuring among the inland dwellers, the Caribou Eskimos. It is primitive because the greatest weight is placed on isolation and not on tricks with which to impress the audience. A conjuror by the name of Igjugarjuk gave me his confidence and told me many interesting things.

Through dreams Sila had made it clear that she had chosen him as her tool. He was at once apprenticed to an old conjuror. His first initiation was in the middle of the winter, during the sharpest cold, when he stayed for thirty days in a small, unheated snow hut, without light, without sleeping skins, just sitting on a little piece of reindeer skin. He fasted during all this time: with days' intermission, there was brought to him through a hole in the snow hut a drink of heated water and just enough food so he would not starve to death. During these thirty days of isolation, enduring intense suffering, he came into touch with his first helping spirits, partly through dreams and partly through fever visions. When the time was up his teacher came with a sled which only he, and not the dogs might pull. Igjugarjuk was then so exhausted that he had to be carried over to it. This training was repeated at intervals until the old teacher deemed the time arrived for the apprentice to commence practice among his comrades.

The conjuror does not stay in the house or tent where the congregation is assembled; he must go out in the open, be out in touch with Sila constantly, in all sorts of weather, fasting for days and steadfastly thinking of the problem before him until he receives an answer from Sila through his helping spirits and can turn back to the snow hut again. Igjugarjuk described his art in the following words:

"The true wisdom is only found far away from people, out in the great loneliness, and can only be reached through suffering. Hardship and suffering are the only things which can open the mind of man to that which is hidden from others."

Another conjuror, a coast Eskimo from Iglulik told me the following: When a young man (or girl) has become aware, through dreams or warnings, that the spirits wish to get in touch with him he gives part of his

Fig. 7

Fig. 8

Fig. 7—Typical tent of caribou skin, Barren Grounds.
Fig. 8—Difficult navigation. Returning from the Barren Grounds to the headquarters of the expedition on Danish Island.

property to a conjuror. Thus when he himself was apprenticed, he had given the conjuror a tent pole to which was tied the wing of a sea gull, as a symbol of the fact that he was to rush through the air to the land of the dead or dive down to the domain of the sea animals. The gift to the conjuror thereafter is set up outside a tent or a house as a present to the helping spirits, and in the evening the conjuror holds an exorcism in the presence of the apprentice and his parents. But first they have to be cleansed: that is, confess breaking of the taboo and all their sins in the presence of the settlement. After this the apprentice is mature enough to follow the customary ritual.

The method by which they enter into possession of their helping spirits shows great imagination. For instance, a ball of fire rushes through the air and enters the body. Every real conjuror has an Angatkua or a Gaumaneq—something which lights up his body, head or brain, an illuminating fire—which not only makes it easy for the spirits to know him but also enables him to see in the dark, literally and metaphorically. He is then in a position to discern hidden things, to look into the future, to read the secrets of others, and in the moment when the spirits are animate in him he feels so great a joy that he must burst into song—a special song which the spirits have taught him.

Many remarkable details were learned from the conjurors all through the Northwest Passage, but on the whole they are similar to the instances described. It is in Alaska only that the East Greenlandic tricks which we know so well from the vivid descriptions of Commander Holms are practiced to any great degree. Here also training takes place in isolation, but sometimes proofs of supernatural powers must be given: for instance, by hanging oneself in the presence of the entire settlement or by letting oneself burn alive. This purifies and cleanses the conjuror so that he becomes strong in his art. I have heard of several cases where the conjuror himself was so sure of his supernatural powers that these demonstrations resulted in death. This fact answers the question as to the genuineness of the conjuror's art. Many are conscious fakers, but there are others who take it in profound earnest.

Importance of the Amulet

That which has already been said regarding the basis of the religion of the Eskimos shows, first of all, that the unintelligible, mysterious powers which maintain the contact between the supernatural and man are dangerous powers to a predominant degree. The conjuror, in spite of all the mysticism with which he surrounds himself, is ultimately only a human being; and the mind of the primitive man demands something more incomprehensible, more fantastic, than anything which can come from a man who at other times lives as an ordinary person. This would appear to be the psychological reason for the great importance of amulets in man's battle against his unseen enemies.

The innumerable taboo regulations must also be noted in this connection. These are especially directed towards women on account of the religious uncleanliness which the Eskimos connect with childbirth and menstruation. Then there is the mysterious force, especially as a shield against illness, which lies in the name. I can instance cases among the Netsiliks of King William Land where a man or woman has from 17 to 20 names. There are also the various magic songs which can be used either as a sort of morning prayer or as a magic communication to hunted game, or otherwise to abolish taboo in such cases where it cannot be carried out for practical reasons. We must here confine ourselves entirely to the question of the amulet. Its importance and comprehensiveness may be gleaned from a simple observation: I have seen a seven-year-old boy wearing not less than 80 of them! A few examples will serve to show the type of material included in our collection of about 300 amulets.

FIG. 9—Holy stone to which the Eskimos offer sacrifices. Sentry Island.

An amulet belt for a man, to be worn outside the fur coat, consists of the nose of a seal and a harpoon point, which bring luck in sealing, and two Tornaq (spirit) whips, with which he lashes in the direction of a pursuing spirit.

Girls as a rule do not carry amulets on their own behalf, except such as ensure that they will become good sewers. An amulet worn by Tugaq, a little girl, for the son she hopes to bear, was comprised of the beak of a swan (the child will be a boy), the claws of an owl (for strong nerves and forcefulness), a grouse (for a rapid and enduring runner), the skin of a sea gull (for luck as a salmon fisher), ermine (strength, dexterity, and endurance), the head, claws, and stomach of a raven (will bring his hunting comrades luck so that he will partake in many hunting parties, for the raven characteristically appears when the booty is put down), the teeth of a bear (the symbol of a hearty eater, gives a fat son).

The sexual organs of a female bear sewed into the back of the trousers has the symbolic meaning that the young man will always stand in the way of the bear and become a great hunter of bears. A thick branch is a sign of growing power; the head of a wolverine means strength; spiders, with which the skin between the fingers is stroked once in a while, make for ability in all handicraft. The hair of a wolverine sewed into a fur collar is especially popular among young men because it makes the beard grow.

Incidentally it may be remarked that every amulet has its special place without which it has no value.

For further interpretation of the significance of the amulet I will take the expositions of two conjurors: one from Iglulik, northeast of Melville Peninsula, the other from Nunivak Island, these places representing extremes of the territory through which we traveled.

The conjuror Aua from Iglulik near Baffin Land described his interpretation of amulets in the following way: "It is not the amulet itself but the soul of the animal from which the amulet is taken which has the helpful, active power. It is, however, not immaterial which part of the animal is taken—it must be certain specific parts." The amulet acts magically, and its power therefore is not bound absolutely to the person who carries it. It can be given away but in such a way that its magical power can only be transferred to its new owner if he presents the giver with great gifts. If he does not do so, the power of the amulet remains with the original owner. For this reason one may keep the magical power even though the amulet itself is lost.

It is also usual to receive an amulet from an old man who has been a good hunter in his time. At Iglulik sleeve bands were bought from a famous old caribou hunter for a boy whose father had always been very unlucky, in fact had never succeeded in bringing down a caribou. The boy had the bands sewed on his sleeves every time he got new clothes, and in contrast to his father, and by the strength of this amulet, he became a very good hunter.

The man from Nunivak, who by the way is the one cited when speaking of Sila, expressed himself as follows:

"The people of a settlement should always have as many different amulets as possible because this gives individual strength. Only the special amulet can do anything special for its owner. If all carry the same amulet, the strength will be split and the men will be poor hunters. A man and a woman with the same amulet may not marry."

In many talks with the Eskimos I always began with the question of whether it was the object itself or its spirit which owned the magical force. For instance, in the case of the claw of the owl; is it the claw which helps the bearer, as a lucky shilling might help, no matter who carries it, or is it the spirit of the owl in a certain mysterious relation to the owner? The answer was everywhere the same: "It is the spirit which helps. The claw is only a symbol."

Hitherto it has been the belief that a regular totemism was practiced among the Eskimos in southern Alaska but that this was entirely foreign to all other Eskimos. In contrast we found continuity in the trend of Eskimo thought and beliefs. A real totemism with clan divisions is not found anywhere among them. The so-called totem marks on the tools of the Alaskan Eskimos are only identification marks to aid recognition, even though they receive something of the character of an amulet by descending

from father to son. On the other hand, the mystical relation between the amulet and its owner, which is found among all the tribes, shows that the Eskimo belief contains the germ of totemism, and the Alaskan Eskimos have undoubtedly progressed further because men and women with the same amulet may not marry.

In passing I shall now remark on the high degree to which religious ceremonial has developed among all the Eskimo tribes.

With the Caribou Eskimos all festivals center around luxurious feasting and singing. Among the Netsilik there is some development of athletic competitions, combined with the same feasts and singing. The festivals are elaborated more and more as one travels farther west, culminating in the Yukon District. This is probably connected with the fact that the Eskimos in southern Alaska have had intimate connections with the Thlingit Indians on the northwest coast of America and, I understand, especially on Nunivak Island. All the festivals are of a religious character. Many of them last for eight days with a constant display of fantastic and complicated ceremonial. Some of them are: the christening feast, the feast for the bladder of the seal, the trading feast, inaugural feast for the kayak, the feast for tying nets, the feast for the great spring hunt, the autumn feast, the big seal feast, and small seal feast, the inaugural feast for new settlements, and the feast for the dead. The last may only be held by the most prominent in the community and for it three years' preparation is involved, as the one who gives the feast must have the booty of at least three years of hunting to give as worthy presents to his guests.

I have enumerated these feasts in this connection because Sila is represented by over 100 different masks which take a direct part in the festivals, and because in several instances a particularly solemn dedication of amulets takes place.

PHYSICAL ANTHROPOLOGY, LINGUISTICS, AND MATERIAL CULTURE

By Kaj Birket-Smith

The tribes studied in detail by the Fifth Thule Expedition were those occupying the regions west and northwest of Hudson Bay. Linguistically and culturally they may be divided into three different groups.

Tribal Divisions: Northern, Western, and Central Groups

The northernmost of the tribes comprises the Tununermiut (people of the place farthest back) of Ponds Inlet, the Iglulingmiut (people of the house place) of Fury and Hecla Strait and the east coast of Melville Peninsula, and the Aivilingmiut (people of the walrus place), living at

Repulse Bay and the western shore of Rowe's Welcome. Since the aboriginal population of Southampton Island, the Sadlermiut (people of the place in front), became extinct in 1902, the Aivilingmiut have taken possession of the entire island. The total number of the whole group is small, being only 507 persons according to the census taken by Therkel Mathiassen. These tribes, at any rate the Tununermiut and Aivilingmiut, are most influenced by white men.

FIG. 10—Sketch map showing the Eskimo tribes west and north of Hudson Bay that were studied in detail by the Fifth Thule Expedition. From Kaj Birket-Smith's map on p. 193 of the *Geografisk Tidskrift*, Vol. 27, 1924.

The western group is generally spoken of by the other Eskimos as Netsilingmiut, but in reality it comprises several tribes besides the one that can justly claim this name. The natives of Simpson Peninsula are known as Arviligjuarmiut (people of the big right whale place). It is a rather considerable tribe, several members of which have emigrated to the Repulse Bay district and settled among the Aivilingmiut. On the other hand, the Sinimiut of Rae and Hall are now practically extinct, there being only two survivors who live near Wager Inlet. The Netsilingmiut proper (people of the fiord seal place) live on Boothia Peninsula and King William Land, the Utkuhigjalingmiut (people of the soapstone place) at the mouth of Back River, and the Haningajormiut (people of the place athwart), or Ualiardlit (the southwesterners), at Lake Garry. The tribe of Simpson Strait is generally known to the ethnologists as the Ugjulingmiut (people of the bearded seal place). This name, however, is not the proper one; they themselves always use the term Iluilermiut (people of the island-like land). Finally Rasmussen discovered a new tribe, or rather a sub-tribe of the Netsilingmiut, viz. the Arveqtormiut (people of the right whale-abounding place) living as far north as Bellot Strait. The western group is the most populous of the three, the number, according to the Rasmussen census, averaging about 600. It is also less influenced by the whites than any other group, in fact probably less than any other tribe of the whole Eskimo stock.

The southernmost group comprises the interesting inland tribes, which, owing to the vital part the caribou play in their lives, we have thought of naming the "Caribou Eskimos," corresponding to the appellation of Copper Eskimos for the natives of Coronation Gulf and Bathurst Inlet. The best known representatives of this group were formerly called "Kinipetu." This name, however, should be deleted from scientific terminology, as it

belongs to the whalers' jargon and is meaningless. The Eskimos never use it, hardly even know it, but call themselves Qaernermiut (people of the flats). This word is mentioned for the first time by Boas as "Kiaknukmiut" and later in another form (Kournoomiut) by the same author, who, however, in that case took it for a name of the Back River Eskimos.[17] More recently Stefansson[18] and Jenness[19] heard it at Coronation Gulf, but likewise thought that it applied to the Back River natives. In reality it is the true appellation of the "Kinipetu."

The Qaernermiut live inland round Baker Lake and Chesterfield Inlet. Formerly, when the whalers visited the coast, some members of the tribe used to winter round the ships at Marble Island and Fullerton, but since the whaling stopped, only two or three families winter on the coast. South of the Qaernermiut, on the lower Kazan River, live the hitherto unknown Harvaqtormiut (people of the rapid-abounding place), and southwest of Rankin Inlet the Hauneqtormiut (people of the bone-abounding place). The first tribe is entirely an inland one and never visits the coast at all, but the second comes annually to the coast late in the spring. South of these tribes again live the Padlimiut (willow people) round Hikoligjuaq and the upper Kazan River and farther east. The western band of this tribe never comes to the coast at all, while the eastern group pays an annual spring visit to the sea just as the Hauneqtormiut do. The total number of Caribou Eskimos amounts to about 500 persons,[20] but during late years they have decreased rapidly owing to terrible famines when the caribou hunting failed. The Padlimiut tribe alone is about as numerous as the other three put together. Although these tribes have been able to procure European goods from Churchill for 200 years, they are less influenced by white men than the Aivilingmiut, who have only been in contact with the whalers for about 60 years. Most of the women and children of the inland tribes had never seen a white man.

Physical Anthropology

Observations on physical anthropology are difficult to obtain in the Arctic. The population is so sparse that the number of persons measured must always be very limited, and furthermore measurements taken in a tent or a snow hut cannot lay claim to the same exactness as those made in a comfortable laboratory. Nevertheless the writer had the opportunity of measuring 112 persons of different tribes, viz. 15 of the Iglulik group, 35 Netsilik Eskimos, and 62 Caribou Eskimos. All of them are men and, with a few exceptions, more than 20 years old. Our collections comprise 3 whole skeletons and about 40 skulls, most of them from Naujan in Repulse Bay,

17 Boas, The Eskimo of Baffin Land and Hudson Bay, p. 480.

18 First work cited in footnote 12, pp. 28, 290, 302.

19 Work cited in footnote 12, p. 49 footnote.

20 Some Padlimiut, of whom we could obtain no exact information, live on the Kazan River south of Hikoligjuaq.

but some from Ponds Inlet, 2 from Southampton Island, and 1 from Eskimo Point. In addition we have several samples of the hair of living persons.

The measurements of 99 men, more than 20 years of age, show an average height of 160.6 cm., a standard deviation of ± 6.0 cm., and a mean error of 0.6 cm.[21] The observations do not group themselves quite symmetrically round the mean, but on the other hand the material is too small to permit of any further conclusions. In other words these Eskimos are below medium height, but do not belong to the really small races and compare favorably with the Japanese and several Siberian tribes. A comparison with other Eskimo tribes is given in the accompanying table.

Table I—Comparison of Stature and Cephalic Measurements

Locality	Stature (cm.)	Cephalic Measurements (mm.)	
		Length	Breadth
Hudson Bay	160.6	193.7	149.7
Point Barrow	161.5		
West Greenland	162.0	192.1	148.5
East Greenland	162.9	192.0	147.0
Coronation Gulf	164.8	195.9	151.8

From this it will appear that the population at Hudson Bay shows the smallest stature of all tribes from which we have material of any importance.

Turning to the cephalic measurements we find the average length of the skull to be 193.7 mm., standard deviation ± 5.9 mm., and mean error 0.6 mm.; average breadth 149.7 mm., standard deviation ± 4.7 mm., and mean error 0.5 mm. A comparison with other tribes is given in Table I.

Hence the dimensions are between the Greenland measurements on one side and the Coronation Gulf measurements on the other, the figures being a little higher than the former and somewhat lower than the latter. The cephalic index is about the same, and these natives must be characterized as a mesocephalic people. In facial measurement also the average is a little below that of the natives of Coronation Gulf, but it is certainly typically Eskimo.

Linguistics

Originally linguistic work was not included in the plans of the Expedition. So extremely scarce, however, is linguistic material from the Central Eskimos it seemed worth while to attempt a collection, although the author is not an expert. He has compiled a comparative, phonetic vocabulary of 500 words from three dialects representing the three main groups of tribes, viz. the Iglulingmiut, the Arviligjuarmiut, and the Padlimiut.[22] To these were

[21] These and the following calculations I owe to my cousin, Dr. J. F. Steffensen, professor of mathematics at the University of Copenhagen, for whose assistance I wish to express my thanks.

[22] Dr. Rasmussen collected similar vocabularies, in the orthography of Kleinschmidt with a few modifications, from the principal dialects between Back River and Nunivak Island in Bering Sea.

added a similar list from the Polar Eskimos and another from the middle part of West Greenland. The vocabularies of the Greenland and Central dialects are very similar. There is, I think, not more difference between West Greenlandic and Netsilik than between English and Scotch, and from the very first meeting both Knud Rasmussen and our own natives conversed

FIG. 11

FIG. 12

FIGS. 11 and 12—Typical woman and young man from the Barren Grounds.

quite freely with the local population. Phonetically, however, there are certain facts of very great interest.

Twenty years ago Thalbitzer proved the existence of a consonant metathesis in the Eskimo dialects.[23] The more primitive forms we have in Alaska, but in southern Baffin Land and Labrador a retrogressive uvularization has taken place. At Smith Sound and in West Greenland we find the same uvularization and in addition a retrogressive labialization.

From a linguistic point of view, there is no such group as the Central Eskimos, though it is a convenient geographical term. The eastern division of the Eskimo dialects may be said to comprise three groups:

1. The Greenland dialects with fully developed metathesis.

2. The Labrador-Baffin Land group, extending as far as Chesterfield Inlet on the west coast of Hudson Bay. Here a retrogressive uvularization has taken place, but no labialization.

[23] William Thalbitzer: A Phonetical Study of the Eskimo Language, *Meddelelser om Grønland*, Vol. 31, 1904.

3. The dialects of the Barren Grounds and the regions round the Magnetic Pole with no metathesis, in this respect related to the Alaskan dialects.

Sometimes the hypothesis is advanced that Alaska is the cradle of the Eskimos on account of the primitive dialects there. It must be emphasized that according to our investigations the most important primitive features of the phonetics extend right to Hudson Bay.

Fig. 13—Woman gathering fuel, Barren Grounds.

Material Culture: The Caribou Eskimos

While the Iglulik and most of the Netsilik tribes live much as other Eskimos, catching seal in winter, deer hunting and trout fishing during the summer, the life of the Caribou tribe is quite different. About two-thirds of this group, i.e. all the Harvaqtormiut, nearly all the Qaernermiut, and more than half of the Padlimiut, never visit the coast at all, and there are grown-up men who have never seen a seal. On one occasion, for instance, they questioned us as to where the horns of the seal were placed, and they forbade us to cut up the walrus meat we were carrying as it was entirely unknown to them. Their main occupation the year round is caribou hunting. The autumn hunt is the most important, for then the deer are fat and the skins fit for clothing. In summer and winter, when caribou hunting is less profitable, the Eskimos fish for trout, whitefish (*Coregonus*), pike, etc. Caribou hunting, however, is the foundation of economic life, and in the early spring, when the cached meat from the autumn has been consumed and the caribou have not arrived yet from the woodland in the south, there are annual periods of starvation, and as a rule several persons succumb to hunger. During the winter these tribes live in snow huts, in the summer they use conical deerskin tents. The only means of conveyance are dog sledges of primitive shape, long and narrow, as the kayak is only used in hunting, and the umiak (women's boat) is entirely unknown. During the summer the sledge dogs are used as beasts of burden.

The remaining third of the Caribou Eskimos live in the same manner, except that they generally come to the coast about the beginning of June

and stay there a couple of months. Here they hunt seal and walrus in wooden canoes, bought at the Hudson's Bay Company's store. Formerly kayaks were used, but these have now disappeared from the whole coast. On the other hand they never hunted whales, not even white whale or narwhal.

The inland character of their civilization is markedly reflected in their religion, which is quite different from that of the coast dwellers. Although

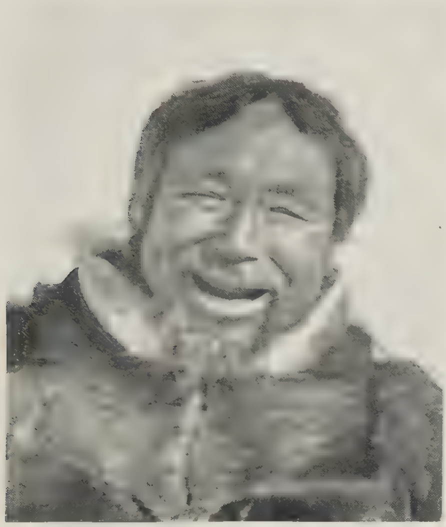

Fig. 14

Fig. 15

Fig. 14—Man from Pelly Bay. His parents had met with members of the Franklin Expedition.
Fig. 15—Umingmagtormiut woman from east of Bathurst Inlet.

they have many traditions similar to those of the Greenlanders, the moon plays no part in their religion. The influence of the moon on the tides, with which the Eskimos on the coast are well acquainted, has no significance here.

Origin of the Culture

Which of the two cultural types is the older one? Eskimo traditions, ethnographical and archeological facts all agree. The Eskimos say that they all used to live inland but that some of them, pressed by the Chipewyans, began visiting the coast. Even in the present coast culture there are survivals from an early inland period; the coast kayak was often covered with deerskin, and, while the Hauneqtormiut use the blubber lamp to a limited degree, the Padlimiut always build heath fires even on the shore and never use blubber for fuel. In spring at the height of the sealing season, when blubber in superabundance was found everywhere in the camp at Eskimo Point, I have seen the women walk for miles inland to gather fuel on the snow-free hilltops. Therkel Mathiassen shows in his archeological

report that a cultural state different from the present one once prevailed along the coast.

We have traced the present coast population back to the inland. Now the question arises: Did the ancestors of the inland population never at some remote period live by the sea? Is it not possible that they are descended from the ancient coast dwellers, adapting their mode of living to inland conditions, possibly under Indian influence? As a matter of fact, some slight Indian influence can be detected among most Central Eskimos; Boas has, for example, called attention to the tobacco pipe and a few myths,[24] and it is only natural that the Caribou Eskimos should be more influenced than the remoter tribes. Cultural elements of Indian origin among the Padlimiut are snowshoes, the flute, the smoking of meat, skin coloring with ocher, and double-curve ornamentation. The style of the last goes to show an influence that is not quite modern, for among those Indian tribes that are in touch with the Padlimiut (i.e. the Chipewyan and Cree) the pure double-curve ornamentation was long ago obscured by European floral designs. On the other hand none of the Indian elements has really been absorbed by the Eskimo culture, they always appear more or less casually. There are other Indian elements which might very well have been adopted by the Eskimos, but which are nevertheless lacking.

We meet with great difficulties, if we try to explain the inland culture as an offshoot from the coast. It is true that for purely geographical reasons some coast elements would be bound to disappear in the interior, but why should an inland population cease to use bola and bird hook, fishing net, adze, the "winged" needlecase, etc., which can be manufactured inland as well as at the coast? And why should they cease to procure blubber from the coast? It is hard to imagine a tribe that once used the blubber lamp moving inland and spending the winter there at a temperature sometimes as low as − 50° C. in entirely unheated snow huts without trying to improve their circumstances.

There are Eskimo inland tribes at Colville River in Alaska. They, however, seem to depend more or less on the coast population, buying blubber for fuel, sealskin thongs, and walrus skins for umiak coverings. On the Barren Grounds it is quite different. The Eskimos here always use heath for fuel, and deerskin boat coverings, and, though they may occasionally buy a few lengths of sealskin thong from the coast, their principal lashings are made of babiche.

The Most Primitive Eskimo Culture

Consequently the writer is at the present time inclined to consider the culture of the Caribou Eskimos the most primitive Eskimo culture known, perhaps a survival of a Proto-Eskimo culture from the time when the transition to coastal life had not yet taken place. It is not believed, however,

[24] Boas, The Eskimo of Baffin Land and Hudson Bay, pp. 365 *et seq.*

that this transition occurred on the shores of Hudson Bay. It must be remembered that the migrations of the caribou are here parallel to the coast and could hardly be supposed to take an original inland population to the sea. Moreover, the topography of the shores of the bay would not invite a tribe to transform its culture; the shallow waters make hunting on the ice rather difficult. Finally the excavations about Hudson Bay show a fully developed coast culture.

FIG. 16—Archers from the neighborhood of the north magnetic pole.

A hypothesis regarding the development of Eskimo culture may be tentatively stated thus:

First of all there was a culture connected with the inland waters.[25] Probably, as supposed by Steensby, it was adapted to the sea ice and formed a Paleo-Eskimo culture. This adaptation probably took place between Coronation Gulf and Boothia Peninsula, where the migrating caribou would take the population to the coast. But the extensive Barren Grounds west of Hudson Bay retained the group which we have called the Caribou Eskimos, thus preserving a stage which might be called Proto-Eskimo.

Afterwards Steensby's Neo-Eskimo stage developed at Bering Strait and spread in an easterly direction.

Finally a fresh advance of comparatively recent date came from the interior and largely obliterated the Neo-Eskimo character of the coast culture.

[25] Cf. the author's treatise "A Geographic Study of the Early History of the Algonquian Indians," *Internatl Archiv. für Ethnogr.*, Vol. 24, Leiden, 1918, pp. 174–222; reference on pp. 215 *et seq.*

I believe that this development fully agrees with the archeological results of Mathiassen, and they are also in harmony with the view of Jenness, who supposes the arrival of the Copper Eskimos at the coast to be a rather late event.[26]

THE ARCHEOLOGY OF THE CENTRAL ESKIMOS

By Therkel Mathiassen

Extensive excavations were made by the writer in the country of the Central Eskimos, the chief sites being near Repulse Bay, Ponds Inlet, and on Southampton Island (see Plate IV).[27] The investigations have a particular interest inasmuch as they represent the first systematic work in the region. On the basis of more or less accidental finds Boas and Thalbitzer had been able to show a noticeable likeness between prehistoric objects from Greenland and finds from Southampton Island and adjacent areas. It was hoped that a thoroughgoing investigation would throw much light on the problem of Eskimo migrations.

In Repulse Bay the work was carried out during two months of the summer of 1922 at Naujan, a locality on the northern shore, briefly mentioned by Hall. Here, on a grassy slope, were found the remains of a large settlement consisting of 20 ruins of winter houses, surrounded by numerous meat caches, graves, and other material. Ten of the house ruins and 60 square meters of an extensive refuse heap, about 1 meter deep, formed before the doorways of three of the houses, were excavated. About 2500 archeological specimens, besides numerous bones of animals, pieces of wood, and other refuse were found. Fifty graves were investigated; and several skeletons, some 20 skulls, and 50 specimens of artefacts were found.

It is a striking fact that the settlement is situated at an elevation of from 12 to 20 meters above the sea and at a distance of 100–150 meters from the shore line; from some of the houses it is not even possible to see the sea. An Eskimo would hardly build his house in such a place, the more so because conditions for building are good near the shore: why should he transport the whale skulls and other heavy building materials, and later on his catch about 10 meters higher than need be? The circumstances suggest that since these houses were built the land has risen 8–10 meters, in the case of the highest (and oldest) houses possibly 13 meters. The many raised beaches also indicate a rapid rise of the land.

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[26] Diamond Jenness: Origin of the Copper Eskimos and Their Copper Culture, *Geogr. Rev.*, Vol. 13, 1923, pp. 540–551.

See also Jenness' paper "A New Eskimo Culture in Hudson Bay," in the July number of the *Geogr. Rev.* —Edit. Note.

[27] Other investigations were made by Freuchen at Chesterfield Inlet, by Birket-Smith at Sentry Island, south of Ranken Inlet, by Bangsted at Vansittart Island, and by Rasmussen on King William Land and Point Hope.

The houses are of the whalebone type,[28] i.e. they are circular, 4 to 5 meters in diameter, half underground. The walls are built of stones, turf, and whale skulls; the roof of whale jawbones and ribs and turf. The back part of the house is occupied by a raised platform covered with flat stones and heath. In some cases two or three houses are connected by a common doorway. The ruins are so old, disintegrated, and overgrown that it was

FIG. 17—House ruin, Southampton Island. Length of spade 1 meter.

impossible to recognize the arrangement in the interior. Moreover, some of the best preserved houses had been despoiled by Eskimos the preceding summer.

The material of the implements and artefacts includes whalebone, ivory, antler, baleen, a little musk-ox horn, slate, green jade, flint, soapstone, a little wood, a few pieces of native copper, and one piece of meteoric iron fitted as a blade into a harpoon head. There are no glass beads or other signs of communication with white men. The objects made of baleen were especially numerous; the lower layers of the refuse heap being very rich in implements of this material, weapon points, knives, bows, arrows, cups, pieces of plaiting, and nets and knots of different kinds.

At Aivilik, another village site in Repulse Bay, one house ruin, standing high above the more recent summer settlement of the Aivilik Eskimos, was excavated and several of the Naujan types were found. Here a recent considerable rise of the land is even more evident. Numerous other house ruins are situated on the coast from south of Sentry Island to Iglulik. According to information obtained by Birket-Smith from the Eskimos,

[28] Whalebone here means the bones of whales; the "whalebone" of commerce is called baleen.

FIG. 18—Types of implements found at Repulse Bay (1–33) and in the Ponds Inlet region (34–42): 1, whaling harpoon head; 2 and 3, common types of harpoon heads; 4, slate blade for a harpoon or lance; 5, ivory foreshaft of lance; 6, a barbed point of baleen; 7, point of barbed harpoon; 8, ivory ice pick; 9, antler arrowhead; 10, bird harpoon; 11, foreshaft of a bird harpoon; 12, barb for salmon spear; 13, ivory salmon decoy; 14, loose foreshaft of harpoon; 15, whalebone ball for bird bola; 16, detachable lance head; 17, flint blade for knife (the best flint implement found); 18, skin scraper, shoulder blade of deer; 19, bow of baleen; 20, handle of woman's knife; 21, miniature *ulo* handle; 22, buckle for dog traces; 23 and 24, knife handles; 25, bone adze head; 26, miniature soapstone lamp; 27, bird, with human forepart, ivory, ornamented; 28, human figure, ivory; 29 and 30, ivory pendants; 31, slate pendants; 32, snow knife of whale rib; 33, blade of mattock of whale rib; 34, part of platform mattress of plaited baleen; 35, baleen cup, with wooden bottom; 36, small ivory cup; 37, mouthpiece of drill, astragalus of caribou; 38, wooden implement, suggesting miniature throwing board; 39, ornamented ivory bow for drill; 40, wooden seal scratcher; 41, slide prong of bird dart; 42, hook for catching gulls.

there are also ruins about one day's journey inland from Sentry Island. I have myself seen house ruins at ten different places between Repulse Bay and Iglulik all of which resemble the Naujan houses in respect of elevation above sea level.

A few scattered implements brought by the Eskimos show that the Naujan types occur all over the country; they also appear in Freuchen's find at Chesterfield Inlet, consisting of 35 specimens.[29]

In northern Baffin Land ruins of winter houses were found in several places, especially in the vicinity of Ponds Inlet. The elevation at which they stand appears to be less than farther south, most often it is about 8 meters but in one case 4–5 meters above sea level. But here too rise of the land since they were erected seems probable. At Ponds Inlet excavations were made during the summer of 1923 at the old settlements Qitalukan and Mitimatalik, both situated near the Hudson's Bay Company's post, and at Button Point on Bylot Island. About 1800 archeological specimens were obtained. Houses and types of implements were in general the same as at Naujan; other specimens found made a valuable supplement. In the summer of 1924, Freuchen carried on the excavations at Qitalukan and among other objects secured a spec-

[29] The collections from Vansittart Island made by Bangsted and numbering about 100 specimens have not yet arrived.

imen of the famous "winged" needlecase. For several reasons the writer is inclined to think that the finds from Ponds Inlet are a little more recent than the Naujan find, though belonging to the same stage of culture.

An interesting Eskimo tribe were the Sadlermiut of Southampton Island who were exterminated in 1902–1903 by disease brought by a whaling vessel. Our previous knowledge of these people was based on the collections secured by Captain Comer and described by Boas.[30] The writer was able to obtain additional information regarding their culture from two old Aivilik Eskimos who had lived and hunted with the Sadlermiut, and he secured also a good collection, found by Eskimos in the deserted villages.

An older stage of their culture is represented by the find of about 800 specimens made during the latter part of August 1922 at Kuk in Duke of York Bay. At this place are many house ruins, the largest group of which, numbering 14, is situated about three kilometers inland. The houses stand close to a salmon dam of the type always built at the mouth of a river: it is now 5 meters above sea level. The implements in the main show the same types as the Naujan find, supplemented by some special Southampton Island types, such as a lamp of cemented limestone slabs, fragments of limestone plates for cooking pots, fine specimens of flint including a knife 20 centimeters long, flint flakers, and sewing needles of ivory. Baleen was here less prominent on account of the poorer chances of preservation. No metal was found and very little wood.

The Kuk find is presumably a little more recent than the Naujan find but evidently closely related to it. The culture of the later Sadlermiut is derived from the old culture and is only slightly modified by local development and by influence from the Aivilik Eskimos.

The Thule Culture

The question now arises: What do these finds imply to the student of Eskimo culture? The territory of the Central Eskimos was in earlier times occupied by an Eskimo culture differing sharply from the culture of the recent tribes—the Aiviliks, Igluliks, Netsiliks, the tribes of the Barren Grounds and of Baffin Land—not only on account of the strong European influence, but as regards the nature of the implements. The old culture seems to have been mainly based on the hunt of sea mammals, especially whales, while the recent people are mainly caribou hunters. The old culture used winter houses of bones, stone, and turf; in the recent one snow houses are used in winter. Such types as square cooking pots, the skin comb, snow probe, wick trimmers of a special form, toggles for dog traces, large dippers of musk ox horn are unknown to the old culture; on the other hand it is distinguished by the bola, bird harpoon, oval cooking pots, pottery, seal scratcher, by a richly ornamental art, and by the use of baleen for almost every purpose. It is interesting to notice, that in the find at Anangiarsuk

[30] Boas, The Eskimo of Baffin Land and Hudson Bay.

of implements belonging to some Eskimos who starved to death about a hundred years ago there is nothing at all to suggest connection with the old culture.

This old culture has been named the Thule culture because the first examples were discovered by members of the Second Thule Expedition in "Comer's Midden" near the Thule station in the Cape York District of northern Greenland,[31] and its extension in the American continent and Arctic archipelago has been proved by the Fifth Thule Expedition. The Thule culture seems to have prevailed when the land was situated 10–13 meters lower than it now is and it was still predominant in Repulse Bay, when a stage had been reached some 5 meters below the present elevation. In northern Baffin Land it was possibly still later, or perhaps Baffin Land is rising more slowly than the mainland. In the north of Southampton Island remains from this culture occur down to 3–4 meters above sea level.

The Thule culture seems to have been superseded by the more recent culture represented by the Aivilik-Iglulik-Ponds Inlet Eskimos. There is some reason for the supposition that this later culture is derived from the interior, the Barren Grounds, where the inland tribes (Qaernermiut, Padlimiut) are still living. Only on Southampton Island, which is difficult of access, was the Thule culture able to persist in a slightly modified form. Whether it originated from actual migrations or only from cultural invasion it is as yet difficult to determine: there are facts supporting both hypotheses. The migration theory is supported by the old Aivilik tales concerning the Tunit, predecessors of the Aiviliks, a strong people who dwelt in earthen winter houses and caught whales and walruses; the men wore bearskin breeches and the women long boots (like the Sadlermiut and the Polar Eskimos); they went farther north when the Innuit (the recent Eskimos) came to the seashore and took possession of their land; the Sadlermiut were the last Tunit in the country. On the other hand some grave finds, especially from Ponds Inlet, seem to be transitional.

Some of the Thule people went to Greenland, where we traced them in "Comer's Midden." A later derivation of the same culture is represented by the finds in northeastern Greenland described by Thomsen, Ryder, and Thalbitzer.[32] In western Greenland most of the Naujan types are found scattered over the country; but the archeology is as yet too little known to allow of further conclusions. The culture of the Polar Eskimos is in many ways closely related to the old Thule culture.

Another branch of the Thule people went into southern Baffin Land and

[31] The part of it now in the American Museum of Natural History has been described by Clark Wissler: Archaeology of the Polar Eskimo, *Anthropol. Papers Amer. Museum of Nat. Hist.*, Vol. 22, 1918, Part III, pp. 105–166.

[32] Thomas Thomsen: Implements and Artefacts of the North East Greenlanders, *Meddelelser om Grønland*, Vol. 44, 1917, pp. 357–496.

C. Ryder: Om den tidligere eskimoiske Bebyggelse af Scoresby Sund: *Meddelelser om Grønland*, Vol. 17, 1895, pp. 281–343.

William Thalbitzer: Ethnological Description of the Amdrup Collection from East Greenland, *Meddelelser om Grønland*, Vol. 28, 1909, pp. 329–542.

Labrador, others spread over the Arctic Archipelago; their routes are always marked by the round, semi-subterranean winter houses.

Farther west similarity with the Thule culture was found by Jenness at Barter Island, west of the Mackenzie. The recent Alaskan culture, as we find it represented in its Arctic phase at Point Barrow, is in fact very closely related to the Thule culture when the comparatively recent Indian influence is eliminated. Of the many similarities between the Thule and Point Barrow cultures mention may be made of the whaling harpoon, seal scratcher, bird bola, baleen net, pottery, the rich ornamental art, the earthen semi-subterranean houses, and the importance of whaling. The Thule culture is much more closely related to the recent Point Barrow culture than to the recent Central Eskimo culture, and there is some reason for the theory that its home is to be found in Alaska.

It looks as if the Thule culture in a remote period existed in a highly homogeneous form from Alaska to Greenland. Expansion from the interior caused this culture to be superseded in the central regions by the culture represented by the recent Central Eskimos. But at the wings, Alaska and Greenland, particularly at Point Barrow and Smiths Sound, the old culture, though modified and further developed in different ways, still lived on. This result seems to agree very well with the similarities pointed out between Southampton Island and Greenland by Boas[33] and Thalbitzer,[34] and with the theory of Jenness[35] that the Copper Eskimos are an inland tribe, which in rather recent time migrated to the seacoast.

CONTRIBUTIONS TO THE PHYSICAL GEOGRAPHY OF THE REGION NORTH OF HUDSON BAY[36]

By Peter Freuchen and Therkel Mathiassen

Northern Baffin Land

In spite of the many expeditions which from time to time have touched its coasts northern Baffin Land has remained among the least known parts of the globe. In consequence it was taken as the main field for the geographic and cartographic work of the Fifth Thule Expedition in spite of the distance from the base, Danish Island.

In the spring of 1922 Freuchen journeyed from Iglulik along the northern shores of Fury and Hecla Strait to the unknown coast west of Cape Hallowell as far as Aggo Bay, and Mathiassen from Iglulik through

[33] Boas, The Eskimo of Baffin Land and Hudson Bay, p. 564.

[34] William Thalbitzer: Der ethnographische Zusammenhang der Eskimo Grönlands mit denen der Hudsonbai, *Baessler-Archiv*, Vol. 2, Leipzig, 1912, pp. 32–44.

[35] Diamond Jenness: *Geogr. Rev.*, Vol. 13, 1923, pp. 540–551; Vol. 15, 1925, pp. 428–437.

[36] See the map, Plate IV, facing p. 562. The names have been submitted to the Geographic Board of Canada and decisions are now pending. Iglulik in the text appears as Igdlulik on the map.

Gifford Inlet, to Admiralty Inlet, mapping the unknown southern half of this large fiord to about latitude 72° 40′ N. In the spring of 1923 Mathiassen took a route through Murray Maxwell Bay to the unknown Steensby Inlet and from here across country to Milne Inlet, the map of which was revised. In the spring of 1924 Freuchen took another route from Murray Maxwell Bay to Milne Inlet and thence to Ponds Inlet, through Eclipse Sound and Navy Board Inlet, along the southern coast of Lancaster Sound to Cape York and back, through the northern half of Admiralty Inlet, from Moffet Inlet across country to Milne Inlet, and again to Ponds Inlet. In addition to our own notes and surveys information obtained from the Eskimos has been used in the drawing of the maps, among others, that of the Anaulurealing Fiord. It is on these foundations that the preliminary map (Pl. IV) has been prepared; but, as the material is as yet far from being completely worked up, reservation must be made for future corrections.

The Archean Terrain

Archean rocks compose the eastern half of our region, a large district to the southwest and a couple of smaller, isolated districts. The topography is varied; to the south, for instance, around Gifford Inlet is a rather monotonous, rolling plateau of 100 to 150 meters in height which drops quite steeply to coast and fiord. Eastward similar country extends to Murray Maxwell Bay. Northward the elevation declines to Admiralty Inlet, the southern part of which is low and rather rough. The rock in this southern section is a uniform, reddish gneiss with rather variable cleavage planes. Here and there, however, the monotonous formation is interrupted by elevated ridges, such as the "saw tooth" mica-schist mountains, in Moffet Inlet and a gabbro mass at Fury and Hecla Strait. The region is a natural continuation of the Archean plateau of Melville Peninsula and, like it, must be considered an old, slightly elevated peneplain, now dissected by ice and water. The summits rise as a rule to the same height, seldom over 200 meters, and as a rule are rounded.

East of Steensby Inlet we find a similar formation. A markedly steep ridge runs from north to southeast of the head of the fiord; it represents a fault-line scarp, forming the boundary between an eastern plateau about 300 to 400 meters high and a western section, low and somewhat rugged. From near the end of Milne Inlet a steep fault-line scarp forms the boundary of the elevated region of the primitive rock. Farthest west, around Milne Inlet and Arctic Sound, the land forms a plateau, 400 to 600 meters high, which drops steeply towards the deeply cut, ice-eroded fiords. To the north the land rises to the east coast, where the plateau is over 1000 meters in height and partly covered by an ice cap. The surface configuration is quite rounded except at the steep ragged borders.

We find even greater heights on Bylot Island, the south coast of which rises like a wall from Ponds Inlet to a height of 1200 to 1300 meters, and

farther inland heights up to 1700 meters have been measured. It is a great alpine land, largely covered by ice from which arise a number of sharply pointed nunataks. In the southeastern corner of the Island a low fore-

FIG. 19—Geological sketch map. For place names see Plate IV.

land fronts the rock wall, probably a beach formed by abrasion, now partly covered by morainic material. The constituent rocks are rather varied—gneiss, granite, mica schist with garnet, amphibolite, etc. Along the southeastern part of Bylot Island there is a broader foreland in front of the high land where the solid rock, at least to the west, is a coal-bearing Tertiary. Southwest of Albert Harbour the highland drops steeply to a low depression. In the river beds and cliffs the Tertiary sequence is ex-

posed, sandstone and clay, alternating with beds of coal; about fifty bags of coal for local use are taken out of the Salmon River Valley every year. Archean also outcrops from the glacial cover in several places in this area.

The Silurian Terrain

The western part of northern Baffin Land is covered by Cambro-Silurian deposits, which increase in thickness from southeast to northwest. Farthest south they form a continuation of the Silurian country of Melville Peninsula. Here the predominant landscape is a very low surface of loose limestone blocks which have been pushed up by the ice until they form regular dunelike ridges; where the land rises ridge after ridge is seen in sequence. When the solid rock appears at the surface, which is seldom, it forms a low flat plateau. Northeastward the surface rises. Between Ikeqtoq and Milne Inlet it consists of the remnants of a broad, comparatively low plateau, on the sides of which the steplike ledges of limestone are plainly exposed; but otherwise nearly everything is covered by loose blocks and beach and glacial deposits. On the boundary against the wall of primitive rock south of Milne Inlet is found a red sandstone with a pronounced dip to the south.

Farther north the rise in elevation continues; most of the country between Navy Board Inlet, Admiralty Inlet, and Prince Regent Inlet forms an extended, monotonous plateau 200 to 400 meters in height. Limestone dominates around the southern part of Admiralty Inlet. At times the rock is exclusively limestone, as in the tabular mountains, Tablerotit and Pusingnajojaq, a good 200 meters in height: at other times slate is intercalated, as at Yellow Valley. The limestone in general is a yellowish gray, quite hard and containing very few fossils (apparently Silurian). The roughness and sharpness of the surface is largely due to wind action.

In places the rock exhibits more variety, as at Giants Castle in Admiralty Inlet. This is a perpendicular wall, about 300 meters high, the lower two-thirds of which consists of an unfossiliferous whitish sandstone with a discordant parallel structure and a rusted surface. Above is a softer layer of sandstone and over this a great overhanging mass of grayish-yellow limestone and bluish-black slate. The entire surface has been carved by erosion into towers, buttresses, caves, and enormous caldrons. Canyons are cut deep in the high plateau, and the walls fall steeply to the fiords. In a river delta at Eqalulik in Admiralty Inlet there are a number of eruptive blocks, basalt and amygdaloid, which must derive from the back country, where later eruptions have covered the sedimentary layers.

The Pleistocene Glaciation

In the Glacial Period the country was entirely covered with ice. Large terminal moraines are numerous. South of the lake Angmalortoq, for instance, is a moraine 40 meters in height and 7 kilometers in length.

FIG. 20

FIG. 21

FIG. 20—Bylot Island from Eclipse Sound, showing the characteristic steep cliffs of the southern coast.
FIG. 21—Stone pillars, where kayaks are placed. Repulse Bay.

Striae are seen in several places; at the mouth of Gifford Inlet (from the north), on Cape Hallowell (from east-northeast), at Siming and Tablerotit (from the east), in Milne Inlet (from the south). They seem to show an ice movement out from the center of the country. The enormous fiords presumably have been formed by ice erosion, even though the valleys probably antedate the Glacial Period. The glaciers must have been deflected by the Bylot Island massif, and Ponds Inlet and Navy Board Inlet have been formed in this way; the steep walls and great depths at Ponds Inlet are probably due to the powerful erosion of the closely packed glacial masses. The high, pointed summits of Bylot Island have, however, probably always projected above the ice as they now do.

The ice is now confined to a comparatively modest area. The center of Bylot Island is covered by ice, and from this large glaciers push out toward the ocean. An ice cap covers the land east of Albert Harbour, and, according to the Eskimos, there is a larger ice cap back of Scott Inlet (longitude 71° W.). There are also small local glaciers at a few places, as north of Low Point at Oliver Sound and west of the lower end of Milne Inlet.

Since the Glacial Period the greater part of the country has been covered by the ocean; at Ponds Inlet there are well defined shore terraces up to a height of 200 meters and west of Milne Inlet up to a height of 400 meters. Beach deposits cover great areas, particularly in the lower country where they form flat plains; such as, for instance, the plain at Saputit. Here the river has cut clay banks, about 10 meters high, exposing a rich marine fauna. Delta deposits, which often afford the only habitable places in the regions of steep coasts, must also be named among the other post-glacial formations.

Melville Peninsula

Melville Peninsula is surrounded on all sides by ice and is accordingly difficult of approach. Committee Bay to the west is always filled with old ice; Fury and Hecla Strait to the north is never open for ships; and the masses of ice which constantly block the coast to the east in Fox Channel and to the south in Frozen Strait make navigating so difficult that the accomplishment of Parry's expedition a hundred years ago must be considered as the height of nautical skill, combined with exceptionally favorable ice conditions.

What we know about the east of Melville Peninsula is due to Parry's descriptions of the coast as seen, however, only from the sea with the exception of the northeastern corner, near Iglulik, where he wintered. Dr. Rae, who traveled over Rae Isthmus and along the west coast in the year 1847, followed the ice along shore and did not go into the interior. Finally, Hall traveled from Repulse Bay to Iglulik and on to Cape Englefield, but his descriptions give practically no geographical information.

Our expedition has explored the southern part of Melville Peninsula

rather thoroughly. In addition Therkel Mathiassen and Peter Freuchen undertook a journey in 1922 to Iglulik, mapping the coast and parts of the interior. Additions and revisions were made by Mathiassen in 1923 and by Freuchen in 1924.

The bed rock of the greater part of the peninsula is Archean, chiefly gneiss. Only in a low, narrow belt in the eastern part do Paleozoic deposits (limestone) appear. The peninsula seems to have been entirely covered by ice. But subsequently the whole country was submerged and the glacial deposits removed in many places. Good examples, however, are seen to the south between Haviland and Gore Bays, especially near the former where a very large terminal moraine cut by the river stretches across the valley. Another was seen in the valley south of Barrow River, the shells found on it showing plainly that it had been submerged.

The expedition found striae at all points visited. At Repulse Bay they show a movement from the fiord down Welcome Strait; on Vansittart Island they point south 20° west, as well as due south and southeast in the southeastern part; along the east coast, where the striae are very plainly seen on the flat gneiss cliffs, they all point southeast.

For the most part the peninsula offers a landscape of monotonous plains of recent unconsolidated material from which project low gneissic knolls or a rather rugged gneissic topography. As a rule the plains are occupied by shallow lakes or marshes, often overgrown with rushes (*Carex*), willows, saxifrage, cassiope, dryas, and various kinds of grasses. The rivers have often cut down through the recent marine deposits showing layers of *Saxicava*, *Cardium*, *Mya truncata*, and other sea shells. The extent of these deposits has not been accurately determined. Strand-line features, at any rate, are found 170 meters above the ocean between Gore and Haviland Bays, but a positive upper limit of submergence cannot be given.

Uplift on the East Coast

At present the entire country is rising rapidly. This is plainly seen in the sequence of beach ridges that make up the entire east coast. There is a considerable difference between high and low tides; and, when there are eastern storms, the ice pushes material against the land, building these great ridges of pebbles and stones. Far out in Fox Channel one finds masses of drift ice carrying huge amounts of shore débris.

Occasional slabs of limestone are found among the boulders in the shore ridges near Vansittart and Danish Islands and also in Repulse Bay. These increase in amount as one travels north. From Usugarsuk in the south of Parry Bay the boundary with the Archean rock is more sharply marked; it withdraws farther back from the coast and may be followed as a line about 200 meters above sea level, running to the north. The shore thenceforward is composed of successive beach ridges rising inland in terrace formation. Usugarsuk itself is a gravel point pushed up by the sea ice; but in other places, as at Anangiarsuk, Amitsoq, and Ignertoq, peninsulas have

been formed in the progress of uplift by the tying of islands to the mainland. This is a phenomenon to be met with in greater or smaller degree all along the coasts here.

In order to make a short cut to the north in 1922, we drove through Hall Lake. This has so recently become a lake that the river to the south still bears the name Ikerasar, which means "sound," and the time can still be remembered when it was possible to sail with a shallow boat

FIG. 22—Reindeer at Point Barrow, Alaska.

round the eastern peninsula, at that time an island. The lake itself is very shallow with numerous gravel islands and ice-packed piles of stones along the shores. It lies outside the area of primitive rock, the border of which, 300 meters in elevation, is marked by a fault-line scarp. The surface of recent unconsolidated deposits is very low, eastward so low that one could hardly tell positively whether one was on the ocean ice or on land at a time when everything was covered with snow. The peninsula Pingerqalik is a broad marsh-covered plain of the usual limestone about 25 meters above sea level. The limestone here is more pronouncedly bluish gray in color and poor in fossils. Outside of Pingerqalik are a couple of small holms of ancient crystalline rock with basalt, exhibiting striae to the south and east.

Iglulik is a low, marshy island of broken limestone. The highest place on the island, west of Turton Bay, rises to about 35 meters elevation. The upper 10 meters consists of a massive limestone, bluish gray, hard and clinking, the beds vertical and as far as we could see unfossiliferous. Nerdlernartok, a low island north of Iglulik, we did not visit.

North and West Coasts and Rae Isthmus

According to Dr. Rae's travel notes, it seems that a mountain ridge rises along the west coast of the peninsula. Thence, according to the Eskimos, the land drops slowly eastward to a depression that stretches in a general way northward from the head of Lyon Inlet. This depression, which

contains many large lakes, is often used as a road from Iglulik to Repulse Bay, via Haviland Bay. East of this we again meet the high, rugged gneiss country characteristic of the interior of the peninsula.

The northern coast toward Fury and Hecla Strait is a high and at times steep gneissic mountain ridge, back of which runs a valley paralleling the strait. Hall traveled to Cape Englefield along this valley as it affords a more comfortable route than the old, uneven ice of the sound.

FIG. 23—Eskimo boy hunting, northern Alaska.

Vansittart Island, Danish Island, and the islands between Gore Bay and Lyon Inlet are the tops of a drowned land, as is the peninsula between Richard's Bay and Hooper Inlet, in the north. The strong tide has kept the channels between the islands deep. Hurd Channel between the mainland and Vansittart Island in particular is remarkable for the raging current that always sweeps it free from ice. Gore Bay and Lyon Inlet possibly represent tectonic depressions in the primitive rock. According to the Eskimos, the latter is continued by a great lake and valley, all the way to Committee Bay. A depression is also said to exist from Ignertoq to Garry Bay. There is at least one other valley between these two; and, if the valley south of Fury and Hecla Strait and this strait itself are also considered as fractures, there is thus a system of parallel valleys traversing the country, an interesting feature but one which cannot be discussed here.

Melville Peninsula itself is attached to the mainland by Rae Isthmus. This was Rae's path to Committee Bay in 1846, and on the Fifth Thule Expedition it was used by Rasmussen and Bangsted on the way to and from the regions west of Melville Peninsula. The tongue of land is described as very low, with a few low gneissic islands, and everywhere covered by unconsolidated deposits. Rift valleys carrying rivers from lake to lake, lead from north to south. The lakes themselves constitute a large part of the tongue. It is said that a terrible wind, especially on the north side,

constantly sweeps the plains free from snow. The tongue has always been of importance to man, in part because it is the most comfortable way for him to travel from Committee Bay to Repulse Bay, but also because of the caribou migrations across this region in the spring and fall.

Life on the Peninsula

Melville Peninsula is known as a good hunting district. The greater number of the caribou pass through here on the way to Cockburnland and back, but in the interior there are caribou in summer as well as in winter. Wolves and wolverines follow in the tracks of the caribou, and there are many foxes and lemmings. The marmot, of which there are quite large colonies, has its northern limit in Fury and Hecla Strait. Bird life is scant except on the small islands off the coast. The low mountains do not afford good fowling cliffs, and, although the marshes would seem to be well suited for wading birds, the great numbers of ermine and foxes prevent hatching. The musk ox is no more to be found but has so lately disappeared that the Eskimos still know the names of men who have hunted it.

The ocean is rich in seals and walrus, and around the south coasts there are still not a few Greenland whales (*Balaena mysticetus*) to be seen; narwhals and white whales (*Delphinapterus leucas*) also appear in small numbers. The rivers are full of salmon trout, in many instances shut into the lakes by the rising of the land. Other fish do not seem to be of any economic importance to the inhabitants.

Driftwood is never found along the coast, and the plant life is of little direct use for the Eskimos. Some cassiope and willows that attain a height of about half a meter in sheltered places in the extreme south of the peninsula are used for firewood, and the branches are braided into mats to be used underneath the skins in the snow huts. A few berries ripen during the summer but are not always gathered.

Trading stations have been established at Repulse Bay by the Hudson's Bay Company where people foregather from the Netsilik as well as from the Aivilik and Iglulik tribes. This is really the country of the Aiviliks, but the strangers often stay a year in the neighborhood when they come to trade. The Iglulik tribe, which is scattered at intervals along the east coast all the way to Lyon Inlet, also take trading trips to Ponds Inlet.

Southampton Island[37]

Southampton Island is another land hard to approach. From the low limestone coasts of the south and west dangerous reefs stretch far out to sea; the steep northern coast is practically always blocked by drift ice from Fox Channel. Only Duke of York and South Bays offer a suitable approach. Button, Bylot and Baffin, Fox, Middleton, Parry, Lyon, and Low

[37] By Therkel Mathiassen.

have made contributions to the delineation of the island; but the first to give a substantially correct view of the island as a whole was the whaler Captain G. Comer in a map published by the American Geographical Society.[38] A later map by Captain H. T. Munn[38] in the *Geographical Journal*[39] adds nothing of importance; and a number of new points shown, especially in the interior, are incorrect. The writer went to Southampton Island in August, 1922, with the intention of remaining there for archeological work for two or three weeks; but drift ice prevented return until the following February. During this half year my Greenlandic interpreter, Jacob Olsen, and I moved about with the Eskimos, living as they did. During the summer we occupied the west coast of Duke of York Bay and visited the northern end of Southampton Island and White Island; in the fall we moved across country to the lower Kirchhoffer River, staying there during the winter. From thence I took a trip to South Bay. The return was made via the Kirchhoffer River and along the coast east of Cape Bylot.

Two Different Terrains

Southampton Island, like Melville Peninsula, includes two different terrains—Archean and Silurian. The primitive rock appears for the most part as a plateau, highest along the coast to the northeast, declining to the southwest; probably it is a peneplain uplifted and tilted. I have measured heights of over 400 meters on the watershed between the Kirchhoffer and Canon Rivers. The Porsild Mountains undoubtedly reach a height of 500 meters; which height is also said to be attained by Mt. Minto on Bell Peninsula. Along the eastern coast of White Island are heights of about 300 meters. To the west the borders of the plateau are somewhat lower, as for instance along the Cleveland River, where they are about 200 meters; at South Bay it is very low. The interior of this terrain is a uniform, high plain covered, for the most part, by loose glacial and marine deposits. From Duke of York Bay to Boas River there is a steep descent to the limestone country: the west side of Duke of York Bay is also formed by a rather steep cliff 200 meters high. On the east the plateau, cut by deep ravines, descends abruptly to the sea. Canon River drops over 300 meters in its course of about 20 kilometers. The upper course is a constant series of falls, often through deep ravines with vertical walls; farther down it flows more smoothly through a deeply cut valley.

The limestone terrain is flat and uniform. West of Duke of York Bay, heights of 38 meters altitude have been measured; the interior is a little higher, but the upgrade is as a rule scarcely noticeable. Around Hansine Lake, however, there is a steplike ascent. Where the bed rock can be seen it consists of a hard, clinking limestone, horizontally bedded

[38] George Comer: A Geographical Description of Southampton Island and Notes upon the Eskimo, *Bull. Amer. Geogr. Soc.*, Vol. 42, 1910, pp. 84–90, with a map on scale 1:2,150,000. See also "Additions to Captain Comer's Map of Southampton Island," *ibid.*, Vol. 45, 1913, pp. 516–518.

[39] H. T. Munn: Southampton Island, *Geogr. Journ.*, Vol. 54, 1919, pp. 52–55.

in some places, as at Kuk, where it is rich in Silurian fossils. Frost action has broken up the limestone into blocks later rearranged by ice and water. It is particularly the ocean that gives stamp to the country now. Especially near the coast the landscape resembles that of Iglulik, exhibiting a succession of beach ridges far inland. The ridges are very irregular in the interior, forming long, rolling elevations above the flat, barren, limestone plateaus, where the loose boulders are still very often in situ. The country around Cleveland River is a vast monotonous plain of limestone gravel, where the solid rock rarely appears. The configuration favors the development of lakes and ponds of all sizes. Around Kuk, for instance, they cover about a quarter of the area, around Cleveland River somewhat less. Wherever the naked limestone appears, either as a solid mass or in loose blocks, the surface is worn exceedingly rough and sharp-edged by the wind. In many places the flat pieces scaled off have been pressed down edgewise so that they cut like knives through the shoe soles. The waterways in the limestone section, as all the waterways on the island, are young. There is a constant succession of small lakes, rapids, and quieter stretches.

FIG. 24—The leader, Knud Rasmussen.

Southampton Island was covered by ice during the Glacial Period, as appears from the extensive morainic material. In two places at Kuk striae have been seen on the solid limestone, both running east-northeast. Now marine postglacial deposits cover most of the surface, in the limestone section as ridges of sharp-edged blocks or as finer gravel, mixed here and there with comminuted shells. At the mouth of Canon River the stream has cut through a layer of clay, containing shells, from 10 to 15 meters thick. Beach gravel has in one case been found 360 meters above the ocean and it covers wide areas on the high plains. It is certain that most of the island, maybe the whole of it, has been submerged since the Glacial Period.

A Good Game Country

The plant life of Southampton Island is very sparse; great areas in the limestone section, for instance around Hansine Lake, being an absolute desert. The great plains around Cleveland River are marshy in part and overgrown with grasses; along the river are willows from 30 to 40 meters high. The high plains have a sparse vegetation where cassiope, saxifrage, carex, luzula, and various grasses predominate.

Of the mammals found on the mainland, musk oxen, wolverines, and

marmots are not found here. Teeth of the first-named, however, were found in a settlement in Kuk; and, according to the Eskimos, there is a musk-ox skull in a house ruin on the south shore. The caribou are still numerous and are said to be of an unusually large variety. In the winter they gather together north and east of South Bay, in the summer they are spread over the island, mostly, however, in the area of primitive rock. Bears are common and wolves very numerous in the caribou district, especially on Bell Peninsula; and there are many foxes, ermine, and lemmings. Formerly the south and west coasts were good whaling districts; now the walrus are numerous in Duke of York Bay and several places on the west and south coasts. There is a rich bird life; especially in the flat, marshy districts towards the southwest, where there are many waders and swimmers. There are four kinds of salmon trout in the rivers and lakes; the most important salmon lakes are Hansine and Qeqertauarlik.

According to the Eskimos, Southampton Island is much the best country in this general region as far as game is concerned. Formerly it was also comparatively well inhabited, as the numerous house ruins show. The inhabitants were of the peculiar Sadlermiut tribe already described. They disappeared earlier from the northern part of the island. The last members of the ancient tribe resided in the settlement Tunirmiut (Native Point) at South Bay. The island is now inhabited by about 30 Aivilik families, who spend the summer at Duke of York Bay or at South Bay, where in 1924 the Hudson's Bay Company established a station, and the winter in the caribou district.

CONCLUSION

In conclusion other results may be very briefly noted. The meteorological work was handicapped by shipwreck on leaving Greenland, when we lost nearly all our instruments and had to replace them in haste with such apparatus as was available. The longest continued series of observations comes from our headquarters, Danish Island, north of Vansittart Island. It extends over about two years with some few short interruptions at times when we all left the station It includes a detailed weather report and thermometric and barometric readings three times a day. There are shorter series of observations from those places where we camped for a considerable period, for instance Baker Lake, Ponds Inlet, etc.; and we also made observations while traveling.

The botanical and zoölogical results include a series of phenological observations. Of special interest is the fact that there are complete collections of plants from a number of localities practically in a line from north to south: Ponds Inlet, Repulse Bay, and Vansittart Island, Eskimo Point, and Churchill; the Northwest Passage is represented by King William

Land, and Alaska by Point Hope. Although we had at headquarters a motor boat intended for hydrographic and marine zoölogic studies, the ice conditions around the island prevented us from using it. The animal life of the ocean is, however, represented by some dredgings in Frozen Strait, south of Vansittart Island. We obtained considerable collections of furs and skeletons of mammals and birds, as well as of insects and arachnida, in general from the same locations as the plant collections.

The collections of the expedition numbered about 20,000 objects of which 15,000 are ethnographic and archeologic—many, as we have indicated, from tribes among whom collections have never been made before. In Copenhagen there already existed smaller but good collections from Greenland. Now we shall be able to show a comprehensive view of Eskimo civilization as a whole from Denmark Strait to the Pacific shores.

A Danish name was connected with the exploration of Hudson Bay 300 years ago when Jens Munk spent a winter at the mouth of what has later become known as Churchill River but which even as late as the eighteenth century was marked on the map as "la rivière danoise." We also come upon the name of a countryman in the opposite corner of North America, Vitus Bering, who discovered the coast of Alaska. It has fallen to our lot to draw the line between these two names, and in gratitude to the country that enabled us to set out and to the two great nations that permitted us to complete the trip, I have the hope that in this way there has not only been added a stone to the Temple of Science but that there has also been taken a step toward advantageous coöperation between the nations.

JAVA: THE ECONOMIC GEOGRAPHY OF A TROPICAL ISLAND*

By S. van Valkenberg
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Java affords a beautiful example of the development of a tropical island under nearly ideal conditions. An advantageous geographical position between Asia and Australia, near the Strait of Malacca, the great trade route to the Far East; a regular, moderate climate with plenteous rains, and no long dry season; a very fertile soil, mainly of recent volcanic origin; a race which is, for the tropics, industrious; and a modern and not unpopular colonial system—these contribute to give Java an importance and a world name far greater than might be expected from its small size.

Java is distinguished by a high percentage of cultivated land and a high density of population. It is without doubt the most intensively cultivated country of the tropics. We may reckon roughly that 80 per cent of the soil is productive. The remaining 20 per cent, which includes also the area occupied by roads, railroads, villages, and so on, is found for the greater part along the south coast. Even this is not wholly unproductive, being suitable for the rearing of goats and sheep. In some places, especially in southern Preanger, such areas are diminishing rapidly.

The population density is the highest in the world for a country depending almost entirely upon agriculture. Java has an area of 131,440 square kilometers (50,750 square miles, a little more than New York State) and a population of 35 millions, that is a population density of 266 per square kilometer (678 per square mile). The density varies between 63 per square kilometer in the rough mountainous region of southern Bantam and 683 in the fertile plain of Jokya. Java has no industries of importance nor any great agglomerations of manual labor in the towns. The people living in towns of more than 50,000 inhabitants form only about 3 per cent of the total as compared with 31 per cent in the United States. Table I shows the population of other agricultural countries in comparison with Java.

The case of Egypt is not strictly comparable for the area given is that of the fertile Nile valley and delta: territorial Egypt is ten times the size. India and China are vast areas covering a great variety of terrains. The most densely populated province of the former is Bengal, which, as the table shows, is closely comparable with Java. Java also compares with the most densely peopled of the Chinese provinces. In Japan the most densely

* The writer is deeply indebted to Mr. C. L. Hoover, Consul General for the U. S. A., for suggestions regarding the manuscript.

FIG. 1—Maps of Java showing relief and communications and important towns. Scale 1:5,750,000.

peopled divisions are industrialized: Kinki includes Osaka; Kwanto includes Tokyo. In the western hemisphere the only comparable unit is Porto Rico, but this island is not one-sixteenth the size of Java. The contrast with Cuba is especially striking; we shall mention it again later.

Table I—Area and Population Density of Various Agricultural Countries[1]

Country	Area in Square Kilometers	Population per Square Kilometer
Egypt	35,363	360
India	4,667,680	68
Bengal	203,830	229
China (proper)	3,877,000	106
Kiangsu	99,300	340
Chekiang	91,200	242
Shantung	149,600	206
Japan	385,521	187
Kinki	23,220	323
Kwanto	32,275	345
Philippines	297,917	35
Cuba	114,524	25
Porto Rico	8,897	146
Java	131,440	266

The high density figure in Java has been attained comparatively recently, largely through the peace brought to the island by Dutch rule in the last century. Table II gives approximate figures showing this progress.

If the influenza epidemic had not affected Java the total population would have been at least a million greater. In fact we may say that Java is on its way to the highest point of typical evolution among tropical countries. Especially interesting is the change of density in the last 25 years (Fig. 3). The two districts showing a small decrease and some with only a small increase seem to have reached saturation point, which in Java depends on the fertility of the soil and on the possibility of irrigation. For instance, in the eastern district of the island of Madura, northeast of the main island, the saturation point seems to be 284, while on the volcanic alluvial plain it easily exceeds 600. Increase has been greatest in the more remote districts which are now beginning to be populated by emigration from other parts. The high figures along the southern coast of East Java indicate the

[1] Figures from Henri Bunle: Superficie et population des contrées de la terre, vers 1920, *Bull. l'Inst. Internatl. de Statistique,* Vol. 21, 1924, Part II, pp. 281–338.

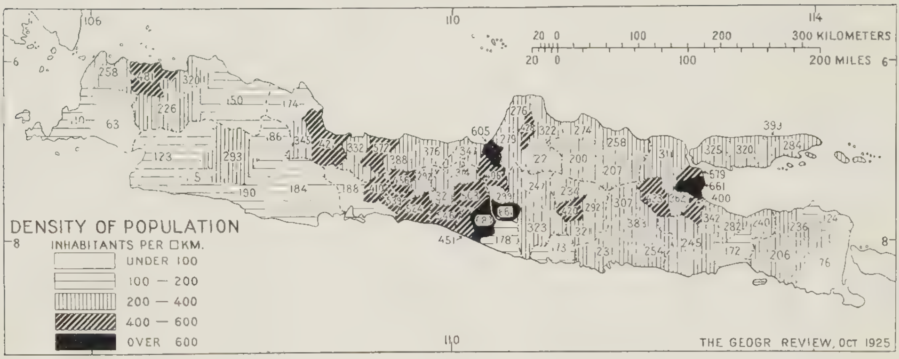

FIG. 2—Cartogram showing density of population according to the census of 1920. Scale, approximately 1:9,500,000.

influence of the sugar industry at the foot of the volcanoes, the coast and the bordering hinterland remaining sparsely populated. Another good example is to the north of Cheribon on the north coast, where the delta of the Tjimanuk has been made suitable for the cultivation of rice and where sanitary conditions have been greatly improved. In the Preanger Regencies the number of estates has increased to the south, especially south of Bandung, and population has correspondingly increased.

In future we may expect a still further increase until the now sparsely populated districts have reached their maximum density. A population of 50 to 60 millions will have to be reckoned with. Meanwhile the question of emigration will soon prove urgent, and the Government hopes that the island of Sumatra (415,382 square kilometers and 14 people per square kilometer) will serve as an area of absorption of the surplus Javan population.

TABLE II—GROWTH OF POPULATION IN JAVA

YEAR	INHABITANTS	PER SQUARE KILOMETER
1800	3 to 4,000,000	30
1850	11,000,000	90
1900	28,000,000	225
1920	35,000,000	266

COMPOSITION OF POPULATION

Of the 35 million inhabitants of Java more than 34 million are natives, 415,000 being foreign Orientals and 135,000 Europeans. The foreign Orientals are for the greater part Chinese. Most of them belong to the middle classes and carry on a retail trade, but many by their diligence and economy have grown rich and become proprietors of large commercial concerns, estates, and factories. The number of Arabs is increasing; they

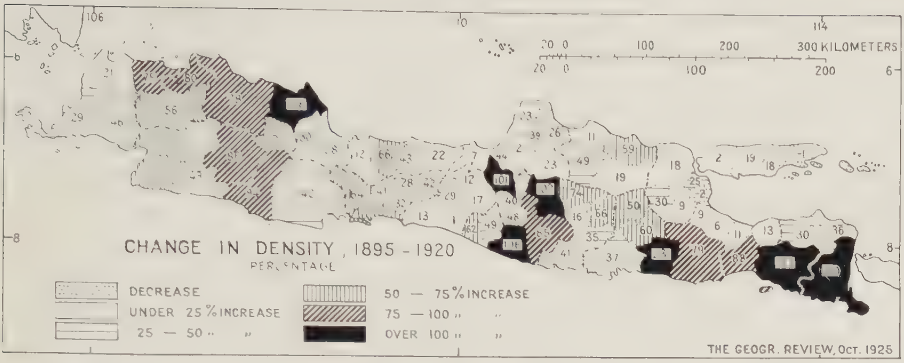

FIG. 3—Cartogram showing changes in density of population 1895–1920. Compare with Figure 2.

too are for the greater part retail dealers, especially in the towns. Of the 135,000 Europeans the great majority, 127,000, are of Dutch origin; but not all are of pure European blood, for no sharp distinction between pure whites and those of mixed blood is made here as it is in India.

For the greater part the white population live in the towns, which are mostly European settlements. Batavia with its suburbs has 300,000 inhabitants, of whom 31,000 are Europeans. Semarang has 160,000, of whom 18,000 are Europeans. Buitenzorg has 5,000 Europeans. Bandung has 100,000 inhabitants, of which number 10,000 are Europeans. Furthermore there are a few smaller towns, as for instance Garut and Sukabumi

TABLE III—DEATH RATES IN JAVA AND NEIGHBORING COUNTRIES

COUNTRY	AVERAGE YEARLY DEATHS PER THOUSAND OF POPULATION	DEATH RATE IN 1918 (INFLUENZA EPIDEMIC)
Java	20	36
India	30	62.4
Philippines	23	41
Federated Malay States	32	53

and Malang, that, as healthful mountain resorts, are favored a good deal by retired Europeans. Solo, or Surakarta, and Jokyakarta, having respectively 135,000 and 103,000 inhabitants, are the only real native towns; but both have rather large white communities. Each of these last two towns is the capital of a Sultanate, formerly independent.

In connection with the population a few words should be said regarding demographic conditions. Generally speaking, and in comparison with the surrounding countries with the sole exception of Australia, health conditions

in the Dutch East Indies are not unfavorable if one judges by the average yearly death rate. Since 1912 the death rate in Java and Madura has been carefully checked and mortality statistics compiled, and the same has been done with regard to the birth rate. The average yearly death rate is found to be about 20 per 1000, or not far from that of Japan. In 1918, the year of the influenza epidemic, this figure rose to 36 per 1000, but it soon dropped until 20 was reached again in 1922. In Table III figures for some of the surrounding countries are given by way of comparison.

The towns, especially those on the northern coast of Java do not show such favorable figures as the rural districts, a fact which is also observed in surrounding countries. The yearly mortality figures of Batavia, Semarang and Surabaya for the last ten years fluctuate between 40 and 60 per 1000, those of the inland towns being on the whole much more favorable. The figures given above all refer to the native population.

For the European population the rates are far more favorable and approximate those found in towns of Europe and America. The average yearly death rate for the European population of Batavia, Semarang, and Surabaya during the last ten years is 16, 19, and 18 per 1000 respectively. Such rates, however, cannot be compared with those of the countries of Europe. The so-called European community in Java really contains a large measure of Javanese blood, and furthermore the pure Europeans are a more or less selected group. The children and women are often sent away from Java because the climate does not agree with them. So too are many men who show signs of ill health. Those who remain are on the whole strong individuals, many of whom are at the most vigorous ages. At home the death rate among such people would probably not be much more than half as high as the actual rate in Java, for Holland as a whole has a rate of only about 13 (13.9 from 1906 to 1913, and lower since 1920).

We shall now examine briefly the physical and economic bases of this flourishing population.

Structure and Topography

Java owes its existence to a huge fold in the crust of the earth. This is called the Sunda fold, and it is part of a great arc of the earth along which disturbances have been continued during late geological time in the Malay region. The effect has been to bow a portion of the crust above the surface of the ocean in a system of folding similar to that in the Alps and the Himalayas. Sumatra and the Sunda Islands, like Java, are the end result of this deep-seated crustal disturbance. In these facts are to be found the explanation of the disposition of the rocks and soils and to a large degree the distribution of the population.

The old rock formations have been folded up to form the high mountains, and wherever the dislocation or bending of the crust of the earth has produced ruptures there volcanoes burst forth. The action of the weather

upon the volcanic mountains resulted in their deep erosion and the covering of the whole surface with a thick layer of tropical soil called laterite. The products of erosion were deposited in the bordering shallow seas as conglomerates, marls, and sandstones. In addition limestone reefs were formed. Further bending or bowing of the earth's crust resulted in the uplift of the marginal areas which turned the reefs into dry land and resulted in a system of relief, drainage, and soils characteristic of limestone regions and

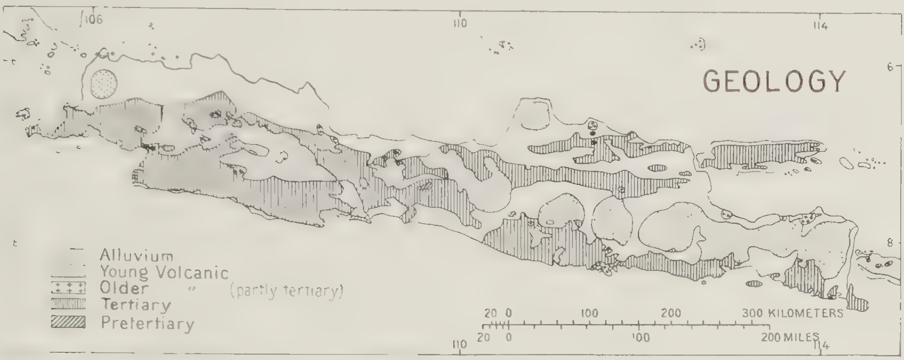

FIG. 4—Geological sketch map of Java. Scale approximately 1:9,500,000.

known technically as "karst" country. The shallow-water marine deposits that were uplifted now form pronounced terraces on the southern coast. The limey reefs have been weathered down, and they are also covered with laterite like the older volcanic deposits to which we have referred. Volcanic activity has continued down to the present time, and it clearly demonstrates that the processes of bowing and rupture and their accompaniments of volcanic activity have not yet run their course.

The entire northern coast of Java, with a few exceptions, is an alluvial plain which, where not covered with laterite, is classed among the most fertile rice and sugar soils of the island. In contrast with the closed south coast Java lies open towards the north. Here the principal commercial towns are situated, although natural harbors do not exist, and the continual silting makes the construction and maintenance of artificial harbors expensive undertakings, Tanjong Priok (the harbor of Batavia) and Surabaya being good examples.

Between the northern plain and the central complex of volcanoes a hilly Tertiary district is found of considerable extent in East Java.[2] This terrain is relatively unproductive and, apart from native secondary crops, is largely devoted to the culture of *jati* (teak) trees.

The numerous volcanoes of West Java form a kind of network enclosing high plains filled with volcanic ash, such as those of Bandung and Garut. In East Java they are more widely separated. Notwithstanding the disas-

[2] Java is commonly divided into East Java, east of the Semarang; Central Java; West Java, west of the Cheribon.

trous eruptions, the volcanoes must be considered a veritable gift of the gods. Their fertile ashes have, to a large extent, covered the Tertiary laterite and made of Java a real garden of the East.

Crops cover the slopes of the volcanic cones to a considerable height, and above the limits of cultivation the remaining primeval forest constitutes a valuable reserve. These volcanic giants have also been beneficial in another direction. Through their great height they promote rainfall during the west monsoon, providing also during the dry season considerable quantities of water for the irrigation of the surrounding plains.

The mountains of Tertiary limestone and conglomerate along the southern coast are quite different from the central volcanoes. Broken at only two places, this mountain range, very rough in places though not lofty, has entirely closed Java on that side. The only harbor, Tjilatjap, is insufficient to provide satisfactory commercial intercourse for the south coast. On the whole, these mountains do not hold out much promise for the future so far as East Java is concerned, but the situation is more hopeful as regards Bantam and Preanger in the west. The extension of the European plantations, more particularly of rubber, has to a considerable extent already opened up this district from the north. The still uncultivated forest-covered areas may prove important in the future. At present the population is sparse, and only the valleys are cultivated.

Only a word is needed about minerals, which naturally stand in close relation to the geological structure. In contrast with the other islands of the archipelago Java is very poor in this form of wealth. The only mineral of economic importance is oil, found in Rembang and north of Surabaya. Production, however, is hardly sufficient to meet the requirements of Java itself.

Climate[3]

The whole of the Netherlands East Indies belongs to the tropical zone, the boundary of which is taken to be the yearly isotherm of 20° C. (68° F.). The climate of this zone, which covers nearly half the globe, is rather uniform, but it includes significant differences that are often overlooked. As regards the effect of climate on man a distinction should be drawn between a climate with a mean temperature of 20° and another of 28° (82.4° F.). With a temperature approaching the limit of human endurance, as is the case in the low-lying plains, the influence of a change of a few degrees is very striking. In Java health resorts are widely distributed on the slopes of the volcanoes, their altitudes ranging between 500 and 1800 meters (1650 and 5900 feet). Every white man goes to a health resort for a few weeks each year if possible; the civil officers, for instance, get an annual two weeks' holiday; women and children generally stay longer.

[3] Based on C. Braak: Het klimaat van Nederlandsch-Indië (The Climate of the Netherlands Indies) (With English Summaries), Batavia, 1923—. Of this work eight parts, forming Volume 1, have already been published, the first four of which were reviewed in the *Geogr. Rev.*, Vol. 14, 1924, p. 496.

FIG 5

FIG. 6

FIG. 5—Tea plantation of Pamegatan, near Garut, at an altitude of about 5000 feet. (This and the following photographs are by courtesy of Th. Weissenborn, Garut, Java.)
FIG. 6—Rice fields near Garut, central volcanic plateau of western Java.

The Rainfall

The Malay Archipelago is the typical monsoon region of the world. In Java we find a time of pronounced east to southeast wind, the so-called east monsoon, in the months of December, January, and February, and a time of pronounced west to northwest wind, the west monsoon, in July, August, and September. The months between have changeable winds. Usually the strength of the wind does not exceed that of a gentle breeze. Even in January and August, when the monsoons are steadiest, their direction is by no means constant. With the exception of the main sea, the deviations from the general monsoon current are usually more marked than the monsoons themselves. Local winds, which owe their existence to insolation and the mountainous character of the country, are strongly developed; and, near the coast, land and sea breezes are pronounced.

The division of seasons is marked, the east monsoon giving the dry season, the west monsoon the wet season. The intensity of the wet season decreases eastwards (toward Australia), and the intensity of the dry season increases: East Java has less rain than West Java (see Fig. 7). The rainfall usually increases strongly toward the mountains, an increase due to thunderstorms as well as to the fact that the winds are forced to rise. A well-known instance is the heavy increase of rainfall between Batavia and Buitenzorg—2600 millimeters in a distance of 50 kilometers.

The distribution of cloudiness and sunshine is similar. On an average for the year the sunshine is about 60–70 per cent of the total possible in the western plains and 70–80 per cent in the eastern plains; in the mountains it decreases to 30–40 per cent.

In exceptionally heavy thunderstorms the intensity of the rainfall in the tropics does not exceed that of similar showers in Europe, but the number of local thunderstorms is much greater, as is also the mean intensity of the rainfall, showers giving 50 millimeters (2 inches) of rain being rather frequent. The maximum rainfall for longer periods is high, the highest maximum being 511 millimeters in 24 hours, while the highest in Europe, according to Hann, is 345 millimeters (13.5 inches).

As a rule, the high mean monthly totals of rainfall are largely dependent on what may be called the local convective effect of the mountains. The rain maps of January and August, when compared with the relief map, give beautiful examples of rain produced in this way during each of the two monsoons. During the daytime, when there is little wind, the mountains act as centers of a strong ascending air movement and consequently give rise to relatively heavy condensation. When the wind is blowing the rainfall on the windward side of the mountains increases and on the lee side decreases. This contrast between the two sides of the mountains is most distinct and may even reverse the rainy season, as appears in Preanger on the southwest coast. Here the January map shows a maximum rainfall in the west of the province, whereas elsewhere the maximum comes in the other half of the year, as appears in the August map.

As regards the yearly rainfall, an amount above 3 meters (118 inches) can be regarded as being very high and occurs only along the mountain slopes.[4] The zone of maximum rainfall occurs about 1200 meters (4000 feet).

For a tropical island the seasonal division of rainfall, especially the amount of rain during the dry season, and the length of the dry periods are of the utmost importance. We have described how convection and thunderstorms produce enough rain in the mountain regions even during the east monsoon, but on the plains the drought is sometimes severe. The average number of months with less than 50 millimeters of rain ranges from one to two on the plains of West Java and from three to four on the plains of East Java; in a few spots the dry period endures six to seven months. During these months cultivation without irrigation is, of course, impossible.

Temperature and Humidity

The temperature depends almost wholly upon altitude: the seasonal variation is very small. For Batavia, for instance, the month having the lowest average temperature is January with 25.3° C., and that having the highest is May with 26.3° C.—a difference of one degree.

The average temperature at different altitudes in Java may be represented approximately by the formula $t = 26.3° - 0.61h$, in which h is the height in hundreds of meters. Table IV is illustrative.

Table IV—Temperatures and Altitudes

Place	Altitude		Average Yearly Temperature	
	Meters	(Feet)	C.°	(F.°)
Batavia	8	(26)	25.9	(78.6)
Buitenzorg . . .	240	(788)	24.8	(76.6)
Bandung	730	(2395)	22.1	(71.2)
Tosari	1735	(5588)	15.9	(60.6)
Gede	3023	(9914)	8.9	(48.0)

In the latitude of Batavia the isotherm of 0° C. lies on an average at a height of 4750 meters, far above the altitude of the highest summits. Frost does not occur at night on the unsheltered mountain tops, but in the mountain valleys and on high, enclosed plateaus where calm nights are the rule frosts occur frequently during the dry months, even at an altitude of 1500 meters, and damage the tea plantations.

The relative humidity changes with the seasons but is always high. As a rule it remains between 85 and 90 per cent, and even in the driest month the mean relative humidity for Batavia is 78 per cent. The readings of the

[4] The highest recorded annual rainfall is 6829 millimeters (278 inches) at Kranggan in the mountain saddle west of Mt. Slamat.

wet bulb give a good indication of the effect of temperature and relative humidity combined. Generally speaking, the weather in Batavia becomes oppressive when the wet bulb temperature rises above 25° C. (77° F.), and then the heat becomes troublesome even in sedentary occupations; when the wet bulb reading exceeds 26° complaints about the heat are general. Fortunately, wet bulb temperatures above 26° are more the exception than the rule. Because of the small change in humidity the wet bulb temperatures are also rather constant and do not differ much from the ordinary temperatures; hence climographs, such as are shown by Griffith Taylor for Australia, are of little value for Java.

As a whole, the climate of Java is not unsuitable for white men living in cool houses, wearing lightweight, white clothes, and not doing hard physical work. In the busy harbor one does not get the impression of tropical lassitude about which one reads so often. In the mountains the climate is excellent; the only drawback—one that exists everywhere and always—is its uniformity, for a change of seasons exerts a stimulating effect on the energy of white men.

Irrigation[5]

For an agricultural country like Java, irrigation is of course of the greatest importance, the cultivation of both rice and sugar depending practically entirely on it. The rivers in Java nearly all have short courses and limited catchment areas. The largest, the Solo River, although running almost across the island, has a basin of only 15,400 square kilometers.

The water supply from the rivers is very irregular. As example we may take the Solo River. The approximate flow per second at normal highest mark is 70,000 cubic feet, during extraordinarily heavy floods 90,000 cubic feet, and at normal lowest mark 810 cubic feet. The river is of a deep brown color, as are most of the Java streams. The quantity of mud carried is 3 10/16 ounces per cubic foot (the Mississippi at New Orleans carries 2 11/16). Consequently there is a strong tendency to form relatively high strips, or natural levees, along the banks in the lower course after inundations. The larger rivers of Java's north coast all form deltas, which grow at a rapid rate. In the case of the Tjimanuk delta an increase of three kilometers has been observed during the last forty years. Everywhere the lowlands are diked. The south coast, for the greater part, is bordered by a mountainous ridge descending steeply into a deep sea, which practically everywhere has a strong surf. Hence no deltas are found.

The district irrigated by a given river is subdivided into secondary squares, which as a rule are bordered by discharge canals whose size depends on field conditions. The secondary squares are again subdivided into tertiary squares, the so-called terminal squares. In these terminal

[5] In this and the following sections use has been made of many official and other sources of information, including the "Handbook of the Netherlands East-Indies," Buitenzorg, 1924.

squares, whose size has lately been fixed as generally as possible at about 100 hectares, the irrigation water is conducted onto the land directly from the so-called tertiary canals. The irrigation canals are provided, wherever necessary, with gauges for proportionate division of the water.

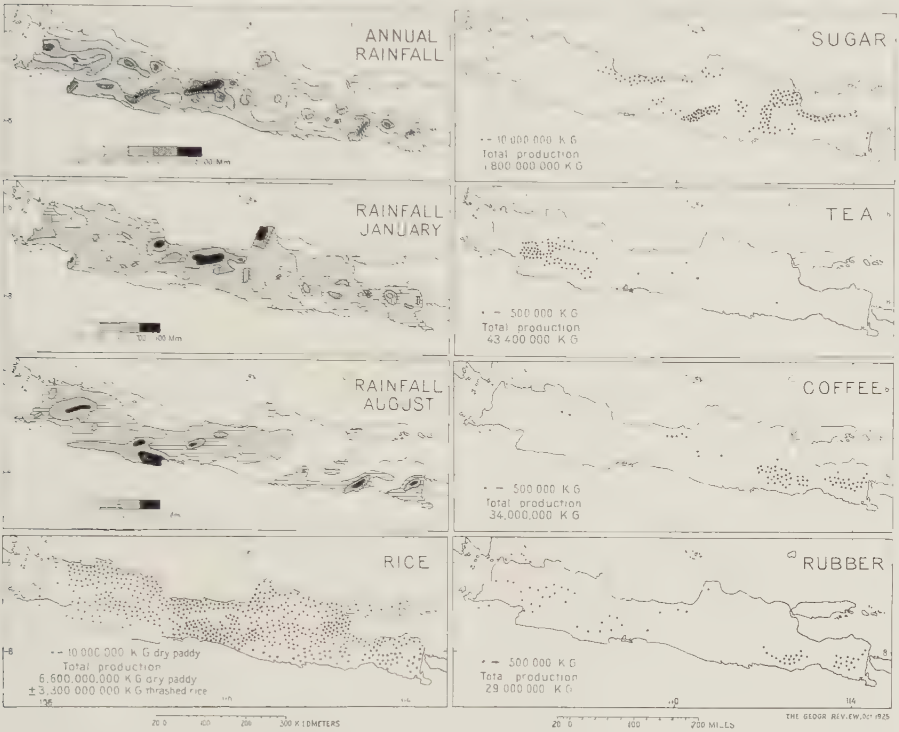

FIG. 7—Rainfall and distribution of the chief crops of Java (units of production represented by a dot, and total production given in kilograms on each cartogram: figures for 1923). Scale approximately 1:19,000,000.

The capacity of the canals is regulated according to the crop requiring most water, namely, rice; for this crop the fields must remain inundated for some time. The quantity of water depends in the main on the porosity of the soil, the gradient of the land, and the height of the ground water, which again depends on the local rainfall. On an average a supply of 1.5 liters per hectare per second for the full period of irrigation can be considered as sufficient in the plains. The comparatively small quantity absorbed by the plant during its growth and the quantity lost by evaporation (about 0.45 liters per hectare per second during the west monsoon, the season when rice is chiefly grown) may be considered as practically stable for the whole of Java.

The magnitude of the irrigation and flood-control work may be judged from the fact that the irrigated districts for which permanent works are now in use have an area not far short of 803,000 hectares (2,000,000 acres), while districts for which permanent works are under construction or

FIG. 8—The temple of Sawal, near Jokyakarta. To the left rice fields ready for harvest.

are being planned amount to 783,000 hectares. The expenditure on irrigation, drainage works, and flood control in 1922 was more than 10,000,000 florins (the par value of the florin or guilder is 40 cents).

NATIVE AGRICULTURE: RICE

Rice is the main product of Java and the staple food. How universally it is raised may be judged from the map, where only the most rugged areas are blank. There are two principal methods of cultivation in Java, viz. culture on non-irrigated fields, still carried on in sparsely populated mountain districts, and the general method of culture in irrigated fields, which are laid out in terraces surrounded by low dikes to retain the water. Cultivation is partly dependent on rain, but wherever possible irrigation is applied. Rice fields are found in the mountains up to altitudes of 1200 meters as well as in the plains. The Javanese even manage to convert slopes with a gradient of 45° into terraces for rice culture. The size of the separate fields, surrounded by dikes, varies from a few square meters to a number of hectares (the hectare = 2.47 acres). In 1922 about 3,000,000 hectares of irrigated land, or about 23 per cent of the whole area of Java, were used for paddy fields. In addition some 350,000 hectares were planted with dry paddy, but this rice is of inferior quality. The young rice plants are set out in the inundated fields at the beginning of the rainy season, the harvest taking place about the beginning of the dry season. During the remaining months, on good rice fields, secondary crops such as Indian corn, cassava, and so on are planted; but very often the fields lie bare until the next season. On the mountains the cultivation of rice goes on without interruption; no special harvest time is observed there, and one can always see rice in all states of growth. Java, even with a production of 3,300,000 tons, does not grow enough rice to feed its inhabitants, although the food of the natives in Java is not so one-sided as it is with most other rice-eating

FIG. 9—Oxen plowing an irrigated rice field.

people. In 1923 rice worth 24,000,000 guilders was imported, but this was partly balanced by an export of 4,000,000 guilders' worth, for Java rice is of very good quality.

Importation seems to be the final recourse in all rice-growing countries. Rice culture alone cannot support a higher density of population than from 200 to 250 per square kilometer; and, the moment the density increases, importation of rice begins. Bengal is a good example of a rice country just on the borderline of self-support. It has 46,700,000 inhabitants; a density of 229 per square kilometer; a rice area of 8.5 million hectares, being 80 to 90 per cent of the total area; and an average rice production of 586 kilos per hectare, or 185 kilos per inhabitant. That production is nearly all consumed; a higher density of population would necessitate imports.

Burma, Siam, and Indo-China are the great rice-exporting countries of the East, all three having a relatively low density of population and immense rice fields. The average yield per hectare of the two former is about the same as in Java, in Indo-China a little lower. Japan has to import rice and is endeavoring to become self-supporting by increasing rice cultivation in Formosa and Korea. In the Philippines rice production, especially the yield per hectare, is still meager, and the import amounts to one-fifth of the production.

Perhaps in the future it may be possible to improve the yield of rice. In Japan it is twice as high as in Java. Up to the present, however, the Government's efforts have not succeeded, as the natives are very conservative.

Other Native Crops

A number of other important crops partly take the place of rice as food—Indian corn (1½ million hectares), cassava (719,000 hectares), sweet potatoes, turnips, peanuts, and so on. The export of cassava is of much importance, in 1923 being 22½ million kilograms of dry roots, 70 million

kilograms of flour, 5½ million kilograms of flakes, and 12 million kilograms of pearl tapioca. The flour goes chiefly to the United States of America.

Another important product is copra. It is difficult to give an idea of the number of coconut trees in Java. A census held in 1917 gave a total of 63,000,000, but at present there are certainly far more. There are also unnumbered tropical fruit trees, but there is no fruit exported except bananas.

Plantation, or Export, Crops

The sugar industry easily occupies first place among the crops grown primarily for export. After Cuba, Java is one of the most important exporters of cane sugar. Sugar is cultivated on the great alluvial plains of Central and East Java (Fig. 7). Sugar estates like those in Cuba scarcely exist, however. The sugar companies in general lease the ground from the natives once in three years for cultivation of a single crop. The Government does not permit the rice area to be diminished greatly nor foreigners to buy the fields. Because of this policy and because of the density of population it does not seem possible to enlarge the area planted to sugar cane to any extent, in contrast with Cuba where much good virgin soil is still available and where the population density is low. Realizing this limitation the sugar producers early aimed at increasing the yield. The Associated Experimental Station for the Java Sugar Industry was established at Pasuruan. As a result of its influence the average yield per hectare is now 11.18 tons, which compares well with Java's neighbors, for example, Queensland, whose average yield is 5 tons, and the Philippines, where the average yield was 2.7 tons in 1918. Comparison with Cuba is difficult, as there the cane fields are not plowed up after each harvest but cropping is continuous for a number of years. The cultivation itself in Cuba is not very intensive because of the vast untouched areas available. The total production of the 182 sugar mills in Java in 1923 was about 1,820,000 tons, being about 10 per cent of the world's sugar production, while Cuba produced 3,600,000 tons.

Tea ranks second of the plantation products. It is grown generally at altitudes of 400 to 1500 meters, the lower estates producing more abundantly, the higher estates giving better quality. The limit of altitude is set by the night frosts. The scientific aspects of the cultivation are carefully studied at the Experimental Station for Tea at Buitenzorg. The number of tea estates is 256, with a planted area of 121,000 hectares; the production of the tea factories is over 40,000,000 kilos, of which nearly 90 per cent is from the estates and the rest is bought from the natives. Java tea production is 10 per cent of that of the whole world.

Probably no product, either in Java or elsewhere, has recently increased in area and value so rapidly as rubber.[6] In 1922 there were in Java 438

[6] Cf. the note "The Twentieth Century Transformation of the Rubber Industry," in the April number of the *Geogr. Rev.*, pp. 316–317.

estates with a planted area of 164,000 hectares, of which 60 per cent was in production. The whole production of Java, Sumatra, and Borneo was about 100,000 tons, or about 25 per cent of the world production; Java, alone, produced 7¼ per cent. The rubber estates are found at altitudes between 100 and 700 meters, the trees often being interplanted with coffee (East Java) and sometimes with tea (West Java). Related to the production of rubber is that of gutta percha from the government estate of Tjipetir.

Coffee, another of the so-called "hill cultivations," has for centuries been one of the exports of Java. Originally the famous Java coffee (*Coffea arabica*) was the chief variety cultivated. Owing, however, to the severe ravages of the coffee leaf blight (*Hemileia vastatrix*) it was decided to plant Liberia coffee. Even this plant did not prove immune to the disease. A stronger species was found in the Robusta coffee, introduced from Africa in 1901. At present another serious pest, the coffee beetle, is spreading in the producing areas. There are now in Java 278 coffee estates, the greater number in East Java, as coffee requires a good dry season. The area amounts to 47,000 hectares planted with coffee alone and 55,000 hectares mixed, chiefly with rubber. The coffee production of Java today, 34,000,000 kilograms, represents only three per cent of the world production.

Java tobacco, especially that from Jokyakarta and Surakarta (Territory of the Native Princes), has always had a very good name, although ranking after the famous Sumatra tobacco. The tobacco companies hire the land from the natives, as is the case with sugar. As the profits are not very large, it is not improbable that a number of tobacco companies will take up sugar cultivation instead as being more profitable.

One of the most interesting crops is cinchona, partly because Java supplies nearly the entire world production of quinine, and partly because the government itself is an estate owner. The large government estate, "Tjintiruan," is at the same time the cinchona experiment station from which seeds and seedlings are sold to other estates. The bark of the tree here yields twice as much quinine as that of the original tree found in Peru and brought to Java 75 years ago. The cinchona estates are nearly all in Preanger, mostly south of Bandung at an altitude of 1500 to 1800 meters. In 1923 the production of 125 estates with a planted area of 16,150 hectares was 8,800,000 kilograms. Java also provides a major share of the world's cocaine, 900 metric tons of coca leaves being exported in 1923.

Cacao production shows sign of decline, although the prices for Java cacao are very high. In recent years the cultivation of fibers, especially of sisal and kapok, has grown in importance.

Pastoral Industry and Forests

In proportion to the population the number of live stock of all kinds is very small. In 1923 there were only 273,000 horses, 2,986,000 cattle,

2,074,000 buffaloes, 97,000 pigs, 1,421,000 goats, and 842,000 sheep. The horses are mainly native ponies, diminutive in size and used in the towns and larger villages for pulling carriages. Pigs are kept only by Chinese, as the natives, being Mohammedans, consider them unclean. The native cattle are found principally in East Java, and they are crossed heavily with Bengalese cattle. The prehistoric-looking buffaloes are used in the rice fields throughout the whole of Java. Australian and Frisian cows are imported and are kept in the mountains to provide the Europeans in the cities with fresh milk. Java is much like Japan in the scarcity of its live stock and utterly different from Australia, which has nearly 100 times as many animals in proportion to the population. For comparison, Table V is given.

Table V—Live Stock in Various Countries

Country	Live Stock (Horses, Cattle, Buffaloes, Pigs, Goats, Sheep)	Average per 1000 Inhabitants
Java (1923)	6,851,000	196
U. S. A. (1921)	203,089,000	1,922
Australia (1919)	103,267,000	18,993
Holland (1919)	3,546,000	519
Japan (1918)	3,313,000	57

The *jati*, or teak, is by far the most valuable forest tree of Java: indeed all other trees are classed as wild timber. The teak forests are a government monopoly. They cover some 735,000 hectares, occupying the lower hill region (below 600 meters) of Central and East Java where there is a pronounced dry season. Teak is used for all purposes where wood is required, for it is durable and resists white ants. Most of the production is consumed domestically.

The forests of wild timber vary considerably in composition according to climate and altitude. Their chief present value depends on their hydrographic influence, the regulation of stream flow. The area of wild timber reserves is about 1,486,500 hectares.

Industry and Trade

The native industry of Java is practically limited to home products and is of no importance for export. The only exception is hat plaiting, the bamboo hats exported in 1923 amounting to 3,000,000 with a value of about 880,000 guilders. About 12,700,000 pandan hats, worth 1,142;000 guilders, were also exported. There are also a number of smaller industries, such as copper work and batik, principally for the home and tourist markets. European industries are only beginning and supply only part of the domestic demand.

FIG. 10

FIG. 11

FIG. 10—The ruins of Borobodur, near Jokyakarta, dating from about a thousand years ago and perhaps the most elaborate of the famous Hindu ruins of Java.

FIG. 11—Houses of bamboo matting at Kampong Papandak, not far from Garut. This type with curved roofs is characteristic of a small area on the western plateau.

In 1920 the value of exports reached the figure of 1,500,000,000 guilders, chiefly as a result of the high sugar prices. Then the great trade depression came, and in 1921 for the first time the trade balance was adverse. Recovery is now in progress, the figure for 1923 reaching 819,000,000 guilders. Of this total, sugar accounted for 60 per cent, tea 8 per cent, rubber 6 per cent; the other chief exports in order of magnitude being tobacco, tapioca, cinchona, coffee, copra. The bulk of the trade was distributed almost evenly among Japan, India, the United States (12 per cent each), England, and Holland (11 per cent each). The two great eastern *entrepôts* also claimed an important share, Hongkong 9 per cent and Singapore 6 per cent.

During the quite exceptional years 1920 and 1921 Javan imports amounted to some 800,000,000 guilders, a value falling rapidly to 500,000,000 in 1922 and 435,000,000 in 1923. Imports are of the usual type required by a tropical agricultural country. In addition we may note the considerable import of rice (5 per cent) to which reference has already been made. Textiles, with England as the chief country of origin, constitute by far the greatest item (28 per cent). The largest contributions from the United States are oil, automobiles, fertilizer, and paper. The oil import is quite illogical seemingly, especially the great import of kerosene: Palembang, on the island of Sumatra, has an export trade in kerosene greater than the American imports into Java. But the policies of the oil trusts (Royal Dutch Shell and Standard Oil) cannot be understood from a geographical standpoint. The paper import consists in the main of overissued newspapers, which are used by all the Chinese shops for packing purposes.

Since the war the largest share in foreign shipping in the Netherlands East Indies has been held by Holland, 44 per cent in 1923, followed by England with 35 per cent. Of the inter-insular trade 80 per cent is in the hands of Holland, England having 12 per cent. Direct steamship lines connect Java with all parts of the world except South America.

Railways and Ports

The road system of Java may be considered good, even without two connections in West Java, which are now under construction. The system consists of northern and southern main roads traversing the island longitudinally and six primary crossroads connecting them. From this system, secondary roads go in all directions. The roads are generally in fair condition, especially considering the torrential rains and the heavy traffic near the towns and in the sugar districts. Motor cars are popular in Java, among natives as well as foreigners, and regular services are in operation.

The railway system has a length of 5339 kilometers, of which 2839 are in the hands of the government and 2500 are owned by private companies. A scheme for electrification of the various state railway lines has been drawn up, and the plan is already being put into execution for the lines near Batavia. For comparison we give the following figures of miles of railway

per 1000 square miles of area: Java 60; India 20; United States 87. Per 100,000 persons the figures are: Java 9, India 12, United States 245.

Batavia, Semarang, and Surabaya are the principal ports of Java: Batavia mainly for the products of West Java, especially tea, rubber, pepper, cinchona; Semarang for Central Java, sugar and tobacco; and Surabaya for East Java, sugar, rubber, coffee, fibers. A number of smaller ports such as Cheribon, Tegal, and Pekalongan ship sugar.

The harbor of Batavia, Tanjong Priok, is situated about 9 kilometers east of the town, the old harbor having been abandoned because of silting. The depth of the channel in the new outer harbor is 9.5 meters at low water, and the port is entirely modern in its equipment. Batavia leads in tonnage of shipping and is the port for the regular mail service to Holland, but the trade movement is of less importance than that of Surabaya.

Surabaya has a good roadstead protected by the island of Madura, and recently a harbor basin has been constructed at considerable expense. A similar improvement is needed for the open roadstead of Semarang, where, during the west monsoon, traffic with the shore is sometimes entirely suspended.

Conclusion

The future of Java depends largely on the evolution of other tropical colonies, especially India and the Philippines. The Javanese, with few exceptions, is content with the present conditions of Dutch rule which assure him a quiet life, untroubled by war and famine. The great educational scheme in progress—nearly all the small villages have government schools—will make it possible to give the natives an increasing share in the management of the country's affairs.

SHANGTU, THE SUMMER CAPITAL OF KUBLAI KHAN

By Lawrence Impey

In Xanadu did Kubla Khan
  A stately pleasure-dome decree;
Where Alph, the sacred river, ran
Through caverns measureless to man
  Down to a sunless sea.
So twice five miles of fertile ground
With walls and towers were girdled round;
And there were gardens bright with sinuous rills,
  Where blossomed many an incense-bearing tree;
And here were forests ancient as the hills,
  Enfolding sunny spots of greenery.

Many of us remember those few lines of Coleridge as one of the landmarks of our youthful education in English literature, words of magic bearing us to some far distant fairy realm. But, alas, how few of those who thus traveled on wings of enchantment have ever had the opportunity to behold the country of their dreams or match the "pleasure-domes" of reality against those of the poet's fashioning. The writer, for one, must confess that he never expected to follow in the footsteps of Kublai Khan on the historic trail from Cambaluc to Ciandu or to stand amidst the ruins of that vast city which the Great Khan built as a summer palace—a marvel and a wonder to all beholders. The Europeans who have passed that way may be numbered on the fingers of both hands, and if one were to exclude those who have given no description of the city or its ruins the total would be still further reduced. Of these, the famous Marco Polo and Father John of Montecorvino and Friar Odoric of Pordenone journeyed to Shangtu, "the city of 108 temples," in the thirteenth century, while Dr. Bushell, of the British Legation in Peking, visited the site in 1872. The account given by the latter is confined to a brief report on the ruins which he found time to examine during his hunting trip in the vicinity,[1] while Odoric of Pordenone is even less explicit in his description, merely giving some account of the departure of the Khan and his retinue for the summer season at Shangtu.[2] As the bulk of the writings of John of Montecorvino appear

[1] S. W. Bushell: Notes of a Journey outside the Great Wall of China, *Proc. Royal Geogr. Soc.*, Vol. 18, 1873–74, pp. 149–167. C. W. Campbell, "Report on a Journey in Mongolia," *British Diplomatic and Consular Repts., China, No. 1, Cd. 1874*, 1904, visited Shangtu but merely says of it, "I have nothing of importance to add to Dr. Bushell's description."

[2] Sir Henry Yule, transl. and edit.: Cathay and the Way Thither, new edit., revised by Henri Cordier; Vol. 2: Odoric of Pordenone, *Hakluyt Soc. Publs.*, Ser. 2, Vol. 33, London, 1913.

Henri Cordier: Les voyages en Asie au XIV^{e} siècle du bienheureux frère Odoric de Pordenone. *Recueil de Voyages et de Documents*, etc., Vol. 10, Paris, 1891.

to have been lost it is in the pages of Marco Polo[3] and the Asiatic historian Rashid-ud-din that our imaginations find satisfaction, for here only can one discover a pen picture whose vividness makes the dry bones of history live and take form. The writer will always remember the surprise and delight he experienced en route to Shangtu when, a day's march from that city, he saw three of the five sorts of cranes so graphically described by Ser Marco and realized that after all the scene had changed but very little since that spring day six hundred and fifty years ago, when the great Venetian traveler first sighted the towers of the imperial summer city. Step by step of the way from Peking, or ancient Cambaluc, the curtain of the years had been rolled back, until it was with a shock that one perceived the long ragged lines of ruined walls and crumpled masses of masonry where once the proud city of Ciandu had been.

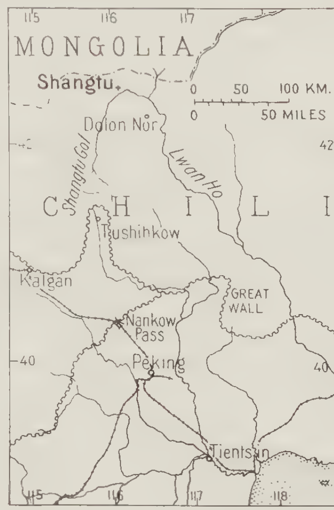

Fig. 1—The situation of Shangtu.

The Road to Shangtu

As soon as the railway had been left behind for good and the baggage mules had begun that long ascent leading to the passes through the Great Wall at Tushihkow one had passed from the China of today into a China of everlasting years, in which the great eastern road to the Mongolian steppes followed its accustomed route of centuries even as when it had echoed to the passing of the hosts of the Great Khan himself. Up the valleys and through the passes winds the road, clearly defined in some places, obliterated in others, but always traceable by its succession of watchtowers. Countless thousands of footsteps have worn away the stones composing the original track, until in places where it crosses some range of hills by a defile the very rock is hollowed out for a couple of feet or more, so that the path of the pilgrim of yesteryear is become a veritable pitfall for the feet of the unwary traveler of today. All the way up, from the Nankow pass above Peking to the last miles of marshland that bring one into the ruins of Shangtu, one finds the watchtowers that guarded the trail for the great Khanate. Never more than five or six miles apart and nearly always so sited as to command a view of the valleys leading into the royal road, these towers are landmarks for miles round.

On the trail itself must have been the posthouses described by Marco Polo:

habitations three or four miles distant one from another, where foot-posts live, having each of them his girdle hung full of shrill sounding bells. These keep themselves always ready,

[3] Sir Henry Yule, transl. and edit.: The Book of Ser Marco Polo the Venetian Concerning the Kingdoms and Marvels of the East, 3rd edit., revised by Henri Cordier, 2 Vols., London, 1903.

> and as often as the Khan's letters are sent to them, convey them speedily to the next post, who hearing the sound of the foot-post coming when at a distance, expect him, and receive his letters, presently carrying them to the next watch, so that it often happens that the King by this means learns news, or receives new fruits, from a place ten days journey distant, in two days. As, for instance, fruits growing in Cambaluc in the morning, by the next day at night are at Ciandu. . . .

One can well picture the posthouses thus described lying in the valley beneath the shadow of the watchtower on the overhanging peak and surrounded by those mud huts and poorer sort of dwellings such as would serve for the housing and stabling of chance wayfarers, who would naturally tend to break their journeys near military protection in such a wild and forbidding country as is this. Even today there is a sense of insecurity as one travels up the pass to Tushihkow and the gate through the Great Wall, the hills towering and frowning down on either side of the trail, while the north wind whistles in the gorges till it seems as if the spirits of dead and forgotten robbers might well be in league with the bandits of today to waylay the weary traveler. That bandits have a real existence the writer had ocular proof, for he chanced to meet three Russians who had been attacked not five miles from a garrison town, one of these unfortunates having been shot through the head by a Mauser bullet.

To return to a consideration of the route followed, the point that most surprises one is the sudden change in the terrain almost immediately after the Great Wall at Tushihkow is passed, for as if by magic the frowning hills fall back on either side and gradually fade away to the horizon, yielding place to a land of undulating grassy plains, a natural ranching country, or so it appears at first sight. Here Chinese settlers from Shantung and Chihli have established their first farms, pushing on a few miles in every succeeding generation while the Mongols slowly retreat before them under the relentless pressure of economic superiority. That there are great possibilities here in spite of climatic disadvantages is evident from the many substantial buildings already erected by Chinese settlers and from the flocks of sheep, the herds of cattle, and the droves of horses amassed by them. For in this lies their principal wealth even now, that from simple agriculturists they have become horse and cattle breeders and dealers, buying from the Mongols their stock, feeding them up for a brief period, and then reselling to the great cities on the plains of China. Ever since the time of the great Khans the Mongol people have been retrogressing. After all, it must be recognized that even at the time of their greatest achievements, when their armies ranged almost unchecked from Peking in the east to Vienna on the west, their paramount position was due to military suzerainty over commercialized countries which contributed both their arts and their wealth to render memorable the rule of the Khanate. Bearing this in mind one is not surprised to find that the thrifty Chinese are steadily encroaching on the territories of the descendants of the great Kublai. What indeed can be the future of such a race as the Mongols, whose sole occupation is the pasturing of numerous herds of indifferent cattle and who

consider it beneath the dignity of a man to do even the slightest manual labor?

Not a village or a *yurt* in the Shangtu area shows signs of agricultural pursuits, in spite of the evident fertility of the soil, nor has any kind of vegetable or grain been grown there for generations. The writer was interested to see whether the great Kublai or his successors had made any endeavor to introduce agriculture here, either encouraged thereto by the advice of Marco Polo or John of Montecorvino or forced to it by the needs of such a city so far from the fertile fields of China. The fact that at some distant date there had been cultivation of the soil was attested by the formation of the ground in a sheltered spot in one of the southern-facing valleys of the surrounding hills, for plowed land leaves a peculiar swell and furrow that is almost unmistakable. In this case proof positive was forthcoming in the finding of a plowshare of iron so ancient that it was practically a mass of rust. It is interesting to speculate as to the source of the food supplies of this imperial city, for, if compared with other cities of China of the time, its very area taken with its suburbs shows that it must have harbored close on two hundred thousand persons. Within two days' march of Shangtu were three other cities whose sites were noted by the writer *en passant*, he having no time to make of them any very close examination. Two of these cities were on the route from Peking to Shangtu, while the third was a day's march to the east, near the town now known as Lama Miao to the Chinese, as Dolon Nor to the Mongol. In formation all these sites appeared similar to that of the outer city of Shangtu, having an earth wall in some places roughly faced with stone, but they differed from the royal city in that they had no inner walls or indeed, so far as could be judged from a cursory examination, any buildings of great importance. It might be suggested that they were intended as garrison towns for forces protecting the capital from sudden attack; and this seems reasonable, though it must

FIG. 2—En route to the Great Wall. Down this valley runs the road followed by the Khanate when visiting Shangtu. This and the following photographs are by Mr. Lawrence Mead.

be admitted that in this case one would expect to find a similar post on the Urga trail. Possibly, however, the watchtowers and the outer zone of earthworks were considered to be adequate protection on that side, there being no site for many miles where water was available.

The city of Shangtu itself must have been a marvelous sight to the eyes of the few Europeans privileged to visit it. Its position in the central plain encircled by beacon-crowned hills must have served to throw the numerous palace buildings and its reported 108 temples into high relief against the surrounding greenery. The usual approach from Tushihkow led up the valley of the Shangtu Gol (or River), and John of Montecorvino notes that before one reached the city one passed numerous buildings which might quite conceivably have served as barracks. The sites lie just to the south of Beacon 1 and a little outside the first line of earthworks, and, as they take the form of a large walled rectangle with numerous small buildings within, all facing onto a central plaza, it is reasonable to suppose that this was in fact a barracks where Kublai Khan quartered some of the numerous soldiery with which he always traveled. In this connection it may not be out of place to quote the picturesque description given by the worthy Friar Odoric of Pordenone of Kublai's journeying from winter to summer capital.

> Now this lord passeth the summer at a certain place which is called Sandu, situated towards the north, and the coolest habitation in the world. But in the winter season he abideth in Cambalech. And when he will ride from the one place to the other this is the order thereof. He hath four armies of horsemen, one of which goeth a day's march in front of him, one at each side, and one a day's march in the rear, so that he goeth always, as it were, in the middle of a cross. And marching thus, each army hath its route laid down for it day by day, and findeth at its halts all necessary provender. The king travelleth in a two-wheeled carriage, in which is formed a very goodly chamber, all of lign-aloes and gold, and covered over with great and fine skins, and set with many precious stones. And the carriage is drawn by four elephants, well broken in and harnessed, and also by four splendid horses, richly caparisoned. And alongside go four barons, who are called Cuthe, keeping watch and ward over the chariot that no hurt come to the king. And none may dare to approach within a stones throw of the carriage, unless those whose duty brings them there. And thus it is that the king travelleth.

Outskirts of the City

Turning again to our examination of the city we find that to the north of it and within the earthworks there is a similar site on a larger scale, and the layout inclines one to the belief that it was possibly intended for the use of cavalry, of which the Khan had a force far in excess of that of his infantry.

Passing inside the earthworks near the southwestern corner the traveler of today follows the causeway of banked earth constructed by the architects of the original city, of which fairly distinct traces still remain, leading on a diagonal to the west gate of the Outer City (Fig. 5). With regard to the earthworks just referred to, the writer would not care to give a definite

FIG. 3

FIG. 4

FIG. 3—Watchtower built by the Great Khan to guard the road to Shangtu: in the background runs the line of the Great Wall.

FIG. 4—A curious building erected by the Khanate on their route near the town of Pingting Obo. The architecture is reminiscent of that to be seen in Tashkent or Samarkand where the Khan Kublai also held sway.

opinion as to their intended use, in spite of a very careful examination, for it appears to him that they might equally well have served for purposes of defense or as boundaries to the hunting park which, according to Marco Polo, the Khan had constructed. It is true that Ser Marco seems to locate the park within the city walls themselves, but an examination of the city shows that its buildings would permit such use only in the northern portion of the Outer City, as indicated on the accompanying map. The writer therefore ventures the suggestion that a deer park may have been located to the north of the city proper but within the earthworks.

The earthworks commence on the west at the river (almost directly south of Beacon 1) and almost parallel the city wall in a northerly direction, though their course is somewhat zigzag. At one point they are pierced by what appears to be the intake for the water supply to the city moat, this apparently coming from the river at a point some distance to the south, that is nearer its source. In order that the water might flow as far as the city moat it would seem that the river must have been at a considerably higher level formerly, which may account for the construction of a causeway. Certainly the fifty-foot stream that is now the Shangtu Gol would neither supply a moat nor threaten to submerge a road. It is possible that this canalized supply had its origin in the vicinity of the ruined city shown on the map some twelve or thirteen miles to the southwest, though the writer is of the opinion that the moat was also filled by additional flood waters coming from the hills to the north of the city of Shangtu.

The valley leading to the northwest (between Beacons 3 and 4) was evidently the most important exit from the plain of Shangtu. It is barred by a dead straight line of earthworks running from the toe of one hill to the toe of the other, some stone facing being still noticeable in places. Presumably this valley leads to the Urga trail and was used by the Khanate forces coming and going on the Karakorum road; it is evidently also a route lending itself to enemy attack on the part of the nomad tribes from the north and west, their bandit activities being a recurrent source of annoyance to the weaker Khanate rulers who succeeded Kublai Khan. Passing eastward from the entrance to the valley one finds a break in the earthen line where is the dried-up site of a lake which probably contains some four or five feet of water after the rainy season in July and August. The writer's theory is that either this lake was formerly of much greater importance, or else its waters were penned up for a time and released into the city moat only during the three months of the year when the Khan was in residence; for at a point just outside the northeast gate there is a division in the direction of the moat which seems to show that it had here a dual source of water supply, the ground level being too high to permit of an intake from the river. The earthworks recommence on the far side of the lake referred to and make a sweep to the southeast, running thence towards the river. Presumably they joined it at one time in a manner similar to that on the west side of the city, but the marshy nature of the ground has engulfed all traces of

the work. It is worth noting that just outside the east gate of the city, and following northward within the earthworks as far as the toe of Beacon 12, is what must have been a very considerable suburb, some traces of which appear to extend to the south, as well, until the ruins are hidden in the marsh and reeds. To the south of the city the writer did not find any defense works whatever; though it is possible that some existed, they could not have been very important to have been thus obliterated.

The City Proper: Outer Walls

Turning from a consideration of the exterior works to an examination of the city of Shangtu proper (see Fig. 6), it appears that the outer walls are between 2300 and 2400 yards in length, with a compass bearing of 184 to 184½ degrees. Thus they deviate slightly from true north and south, supposing the compass to have been entirely accurate. It would appear to the writer that the site of Shangtu was occupied by a city before the time of Kublai Khan, who is recorded as being its builder, for the outer walls from Station 1 to Station 9, from Station 9 to Station 8, and from Station 8 to Station 7 are of different composition from the rest, being of earth only, with a core of stone showing at a point between Station 1 and Station 2. It is difficult to be certain as to this, for the Great Khan did undoubtedly improve and strengthen these walls if they were of a previous date, the gates and moat, from their similarity to the remainder of the fortifications, being almost certainly of his design. This theory of the reconstruction of the city is borne out by the account of it given by the historian Rashid-ud-din, A. D. 1247, who says:

> On the eastern side of the city (i.e. Kaimingfu, afterwards called Shangtu) a karsi or palace was built called Langtin, after a plan which the Khan had seen in a dream and retained in his memory. The philosophers and architects being consulted gave their advice as to the building of this other palace. They all agreed that the best site for it was a certain lake encompassed with meadows near the city of Kaimingfu, but for this it was necessary to provide a dry foundation. Now there is a kind of stone found in that country which is used instead of firewood, so they collected a great quantity of that stone and likewise of wood, and filled up the lake and its springs with a mass of bricks and lime well shaken up together, running over the whole a quantity of melted tin and lead. The platform so formed was as high as a man. The water that was thus imprisoned in the bowels of the earth in the course of time forced outlets in sundry places, and thus fountains were produced. On the foundation formed as has been described a palace in the Chinese taste was erected, and enclosed by a marble wall. From this wall starts an outer fence of wood which surrounds the park, to prevent any one from entering, and to preserve the game. Inside the city itself a second palace was built, about a bowshot from the first; but the Khan generally takes up his residence in the palace outside the town.

To return to our exploration of the site, it may be noted that there is now no sign of a moat on the south side of the city, probably owing to the marshy nature of the soil and the proximity of the river; but all along the west side and for some distance along the north wall it is remarkably clearly defined. It is somewhat difficult to determine the exact thickness of the

walls owing to erosion and collapse, but a fair estimate can be formed from an examination of the attached cross sections taken at different points along them. It must be remembered that the whole site of the city has

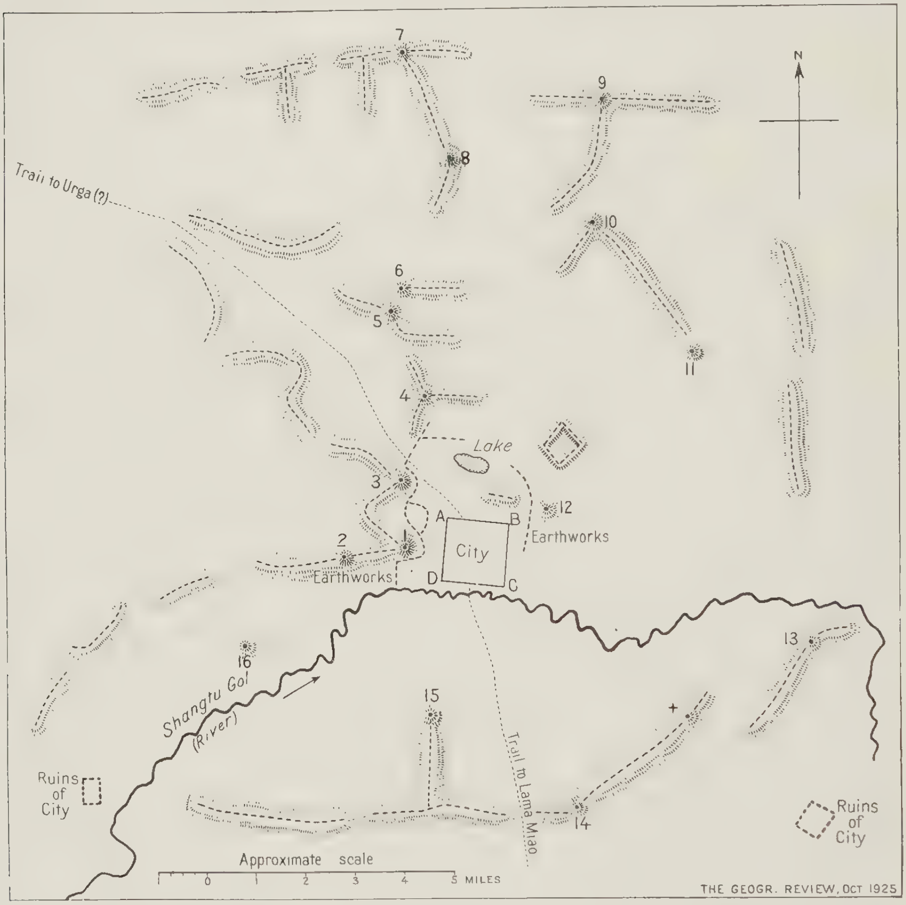

FIG. 5—Map of Shangtu region showing hills and watchtowers plotted by compass bearings, rivers sketched in approximately.

Compass readings are: From Station 12-B, 249; C, 208; 1, 257; 2, 257½; 3, 282; 4, 314; 5, 322½; 6, 327½; 7, 343; 8, 345; 9, 7½; 10, 10; 11, 43½; 13, 118½; X, 146; 14, 174½; 15, 210. Station 6-A, 169; B, 155; 1, 180; 2, 193; 3, 181; 4, 168½; 5, 213; 7, 360; 8, 19½; 9, 46½; 10, 71½; 11, 103; 12, 147½; 15, 177½. Station 3-A, 128½; B, 111; C, 157½; 1, 175; 2, 217; 4, 14; 5, 355; 6, 359; 7, 8½; 8, 53½; 12, 101; 13, 112; 14, 152; 15, 173; 16, 224. Station 2-16, 229; 1, 79½; 3, 37½, 4, 26½; 5, 10½; 6, 12½; 11, 59½; 12, 77; 13, 100½; X, 115; 14, 138; 15, 152. The readings were taken with a compass not checked for variation, and some allowance should be made for vibration caused by wind on the hill crests. The city walls are 4½ to 5 degrees from north, so that there may be some variation in compass and some error in the ancient methods used by the architect.

undoubtedly silted up to a considerable depth during the last five hundred years. The writer would imagine that there is at least five feet of top soil which has drifted in and more than that in the moats. It is obvious, therefore, that measurements of the actual wall footings were impossible in most places without preliminary excavation, for which there was neither time nor money.

Beginning with the earthen wall of the outer city at Station 2, the first point noticeable is the stone core of the earthwork, measuring 3 feet 10 inches in width, a core which is not traceable at some of the other points

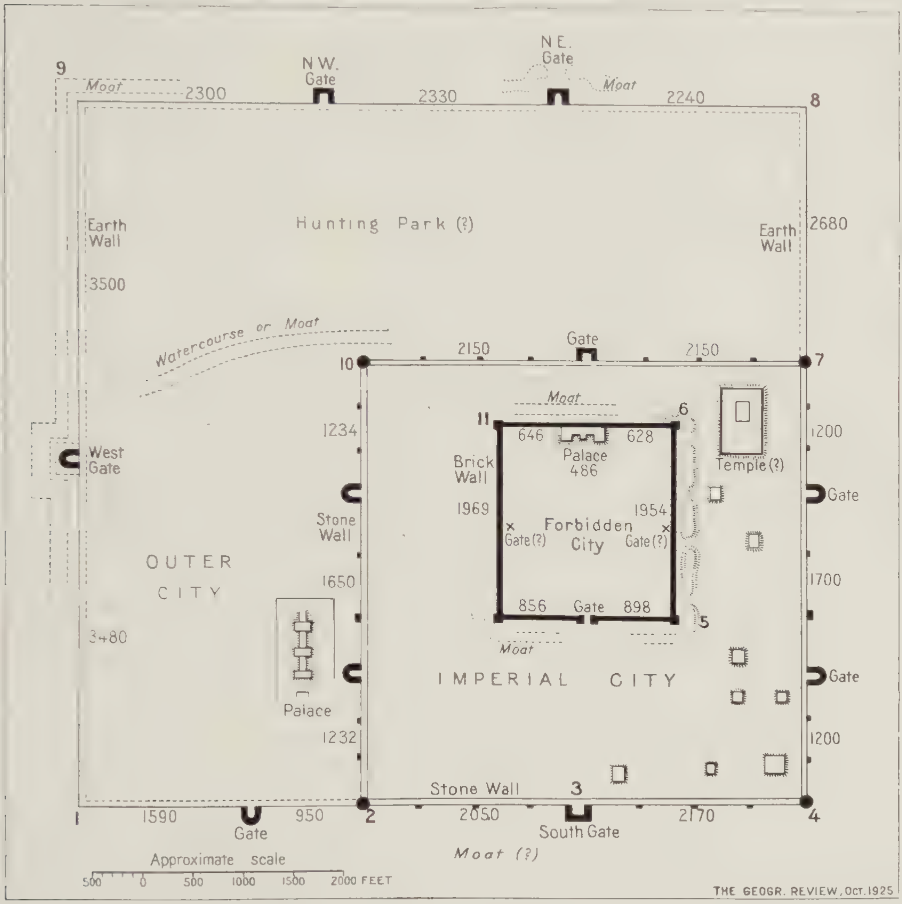

FIG. 6—Map of the City of Shangtu. The measurements were taken with linen tape and checked twice. A moat possibly existed to the south, but if so it has been obliterated by swamps in the vicinity of the river.

where time has eroded the surface of the wall. The gateway measures approximately 195 feet in width and 196 feet in depth, the height averaging 12 feet; its shape was semicircular, and it was faced with rough stone. As far as can be ascertained, the exit was towards the south; but this is difficult to determine without excavation owing to the collapse of the stone facing and the accumulation of débris under what must have been the arch of the gate. At Station 1 there was a tower of circular form, judging from the stonework remains and the higher elevation of the wall at this point and also from the fact that there are similar and more distinct remains at the southeastern extremity of the wall at Station 4; although, as this was a stone wall in any case, nothing decisive can be proved.

The gate on the west wall is of a similar type to the one just described on the south, being faced with stone and semicircular in form; but in addition it has a curtain measuring 90 by 267 feet projecting to the moat 14 feet away. The approximate dimensions of the gate are 211 feet in width and 223 feet in depth; the exit must have been to the west, for there are indications that a bridge existed here across the moat from the approach causeway. At this point the line of outer earthworks most nearly approaches the city, being only about four hundred yards away and very clearly defined; while from this gate to the northwest corner of the outer city the moat is most plainly marked also. Just beyond the angle the present depth of the moat is 9 feet 6 inches while its width is 132 feet, to which one may add probably another 7 to 10 feet for driftage. It is possible that there was stone facing at least on some part of its surface; but there are now no traces remaining.

Turning east along the north wall there is nothing of note until one comes to the northwest gate, which, judging from its size and the fallen stones which mark its site, appears to have been one of the most important exits from the city. This importance is probably due to the fact that the main trail from Shangtu leads, as before remarked, up the valley to the northwest. The gate is rectangular both within and without and measures 222 feet in width and 220 feet in depth, being faced with stone. Between this gate and the next there is now a large gap in the wall, apparently used as the exit of a main trail from Lama Miao to the northwest valley and probably to Urga, a city of comparatively recent interest. The northeastern gate, judging from its construction and the comparative absence of stone work, was not so important in its functions. Its shape varies slightly, being rectangular outside and apparently semicircular inside; its width is 200 feet and its depth 216 feet.

It seems probable that the northern gates were the exits to sites of interment, for at some little distance there are several structures that resemble Chinese cemeteries in their plan, with what are apparently sacrificial altars en route and at the grave sites. While discussing this point of sepulture the writer may instance the curious workings of chance, for during a whole month of research and measurements in the city and its vicinity he did not discover a single location that perfectly satisfied him as being a cemetery, though it was obvious that the inhabitants of the city must have been buried somewhere near, it being manifestly impossible for them all to have been transported to Peking or to their ancestral tombs in the Altai Mountains. The problem was eventually solved by an elusive antelope, in pursuit of which the writer penetrated to a considerable distance the range of hills to the south of the river. Here in a secluded valley he stumbled on a group of ruins that could be nothing else than graves, for there was neither water supply nor encircling walls to denote the existence of a town. Here doubtless sleep some of the worthy citizens and magistrates of Shangtu whom Marco Polo knew and admired. In passing it may be noted that one stone

which the writer examined in the ruins of Shangtu had a rough cross on the reverse side. Though this single fact by no means proves its Christian origin, one may imagine that here, perhaps, is a record of a convert of worthy John of Montecorvino, the stone itself perchance serving to mark the grave of some long-forgotten citizen of Shangtu.

Returning to the examination of the city wall, one passes without remark from the northeastern gate to the corner of the city, this point being the

Fig. 7—The famous "devil dance" at Dolon Nor (Lama Miao), which very few foreigners are privileged to behold. This takes place in July, and Mongols come in thousands to see it.

highest elevation on the wall line. From here there is no visible trace of any extension of the moat down the eastern side of the city. Just to the north of Station 7 is a gap through which passes the Lama Miao-Urga trail. At Station 7 itself the Outer City wall joins the Imperial City wall and thenceforward is faced with stone. This spot is marked by the débris of what appears to have been a circular tower, measurement of which shows the base diameter to have been approximately 74 feet. The facing is of stone, and one would suppose that the batter would have been the same as that of the still existent tower at Station 10, namely one in five. The measurements of the wall just to the south of Station 7 were taken at a height of 14 feet from the ground and approximately 20 feet above the former footings, showing a width of 25 feet and a batter of one in four. Just below this there occurs the first bastion, which is rectangular in shape, measuring 35 feet in width and 21 feet in depth, the batter being nearly the same as that of the wall.

It is interesting to note this use of rectangular bastions in the East, such a construction having been first seen in Europe, as far as the writer is aware, in the beginning of the thirteenth century. One may speculate as to whether the design came from a common source such as Constantinople or some other

city of the Middle East, whether the idea originated spontaneously and simultaneously, or whether Marco Polo or his father taught the engineers of the Great Khan this art of military fortification. On the eastern wall there are two of these bastions spaced between each of the gates and the corner turrets, and they correspond almost exactly with those on the western wall of the Imperial City, the dimensions in all cases being presumably the same, though only three of them are in a sufficiently good state of preservation to permit of accurate measurements.

The first gate on the eastern side of the city is 196 feet in width and 203 feet in depth and was semicircular in form, the exit, as far as one can judge without excavation, being to the east. Passing south it is worth noting that the second bastion, which is the one next to the southeastern gate and opposite the southwest corner tower of the Forbidden City, is considerably larger than its fellows, though the broken nature of its débris renders measurements difficult. A similar bastion is to be found exactly opposite it on the western wall of the Imperial City, and this is in a better state of preservation, measuring approximately 48 feet in width and 32 feet in depth. On top of the western structure there seems to have been a smaller turret of rectangular form about 14 feet by 12, the height above present ground level being 18 feet; and it is reasonable to suppose that this construction was followed out in the eastern bastion also. The second gate on the eastern wall measures 188 feet in width and 200 feet in depth and, like the first, was faced with stone and was semicircular in form. The two bastions to the south of this are now only mounds of débris and present nothing of particular interest, while the circular tower at the southeastern extremity of the wall is similar to the one at Station 7.

The wall dimensions on the south taken at a height of 13 feet above the present ground level show 23 feet in width with a batter of one in three and a half. There is a ramp at Station 4 measuring 12 feet in width and 36 feet in depth, giving access to the wall on its southern side from the interior angle. There are three bastions between this point and the main south gate, which appears to have been intended to occupy a central position in the city wall and which is perhaps the most clearly defined and strongest of them all, measuring 193 feet in width and 211 feet in depth and being faced with heavy masonry. The form is rectangular. Three more bastion ruins carry the wall along to Station 2, where it joins the earth wall of the Outer City again, the spot being crowned by the ruins of a turret similar to those at the other corners of the city previously examined.

Western and Northern Walls of the Imperial City

From Station 2 the masonry wall of the Imperial City turns northward and is clearly defined for some distance, there being, as on the eastern wall, two bastions before the first gate to the west is reached. This gate is in a state of good preservation, enabling one to measure the exit and the facing

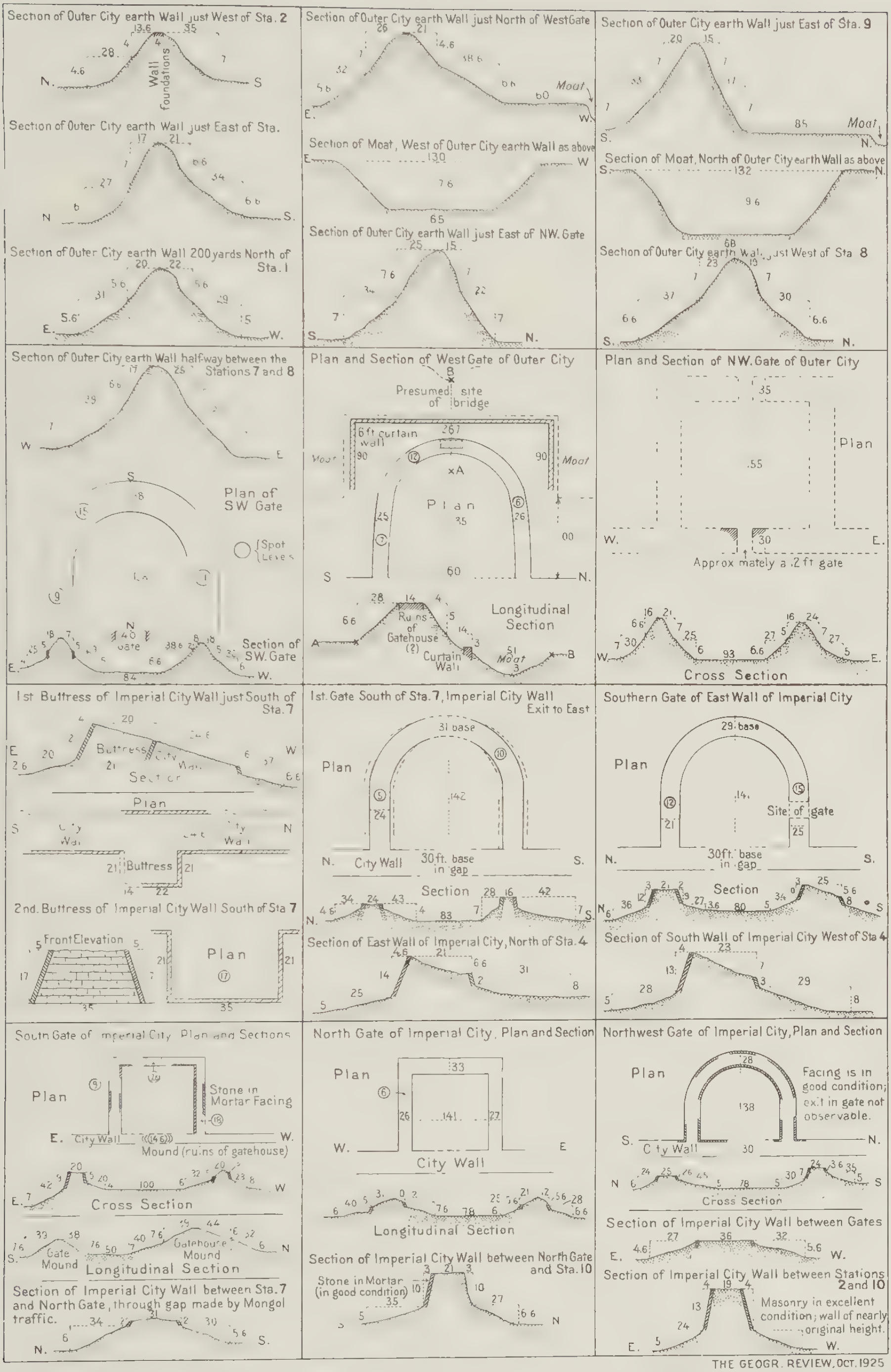

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FIG. 8—Typical plans and sections of the ruins of Shangtu. For locations see Figure 6. Relation between the horizontal and vertical scale varies, in most cases the vertical being exaggerated two or four times. Figures in feet.

of the interior and exterior walls, the width of it being 193 feet and the depth 204 feet, while the stone facing has a batter of one in five and an average height of 14 feet. It is uncertain whether a wall existed here before the construction of Kublai Khan's city; if the previous city was walled, one would suppose there would be gates facing the reverse way, though it is possible that Kublai simply used the old material and shifted the gates to face the other way, adding a stone casing to the previous earth wall. This theory is to some extent substantiated by the curious construction of the next gate,

FIG. 9—The passage through the Great Wall at Tushihkow. The wall is seen running across the valley on the right. A temple dedicated to travelers is just within the gate amongst the trees.

which had no exit traceable and appears to have been a dummy gate built to render the city plan uniform.

The western wall measurements taken at a height of 5 feet above present ground level show a width of 36 feet, while those taken at a height of 18 feet give a width of 19 feet, so that if one estimates the depth to the actual footings as being another 6 feet it would seem that the base of the wall should approximate to 40 feet, while the top measurement after allowing for erosion would be about 16 feet. The corner turret at Station 10 is the best preserved of the four, the diameter being approximately 75 feet and the height 27 feet. It appears that there was a small rectangular building on the summit, faint traces of which are still observable as a building line; in the débris the writer found fused and twisted bits of metal, evidently relics of the fire with which the Chinese destroyed the whole city on its capture from the last of the Khanate. The width of the wall is 35 feet at ground level at this point, and thence a succession of three bastions carry the line along eastward to the northern gate of the Imperial City, this gate being immediately behind what appears to have been the site of the Imperial Palace in the Forbidden City. The gate is rectangular in form, like its counterpart to the south of the city, while the measurements show a width of 194 feet and a depth of 214 feet, with an exit to the north. The northern wall measurement taken at a point 15 feet above present ground

level gives a width of 22 feet, and the line seems to be much the same for the remainder of the distance to Station 7, there being the balancing three bastions between the north gate and that point.

Walls of the Forbidden City

Leaving the wall of the Imperial City one turns next to that of the Forbidden City, which appears to have contained far more brick and less stone

Fig. 10—A typical scene across the Mongolian plain with its setting of low hills. The village is crowded with Mongols and Chinese who have come from far and near to see a traveling theatrical company.

and to have been more nearly perpendicular, the foot, judging from the traces still remaining, having been protected by a moat for its whole circumference. Beginning at Station 6 it is to be noticed that the circular form of corner turret has been abandoned in favor of a rectangular one, as is plainly indicated by the wall foundations shown in hatched line on the large-scale plan. These remains give the general line quite plainly, and the theory of design is further proved by the measurements taken on the southwestern corner of the Forbidden City, where the outline of the turret is even more clearly defined. Unfortunately it seems that generations of lamas from the near-by temple have made a practice of obtaining building material thence and from the adjacent wall, with the result that the surface layer has in many places been removed, though the second or third course is still *in situ* for considerable distances.

The Forbidden City itself is rectangular, measuring approximately 1750 feet east and west by 1960 feet north and south. The wall dimensions taken at various points give a width of 20 feet at 11 feet above present ground level; but a better idea of its contour can be obtained from an examination of the accompanying sections. In the eastern wall of the city there is a considerable gap, shown in Figure 11, where it is possible there existed a gate in former times. Marco Polo makes no mention of it, but Dr. Bushell recorded it when he visited the city in 1872, stating that there were both

eastern and western gates, and a southern gate in a good state of repair. The arch of the southern gate has now collapsed, but its remains are clearly defined and easily measurable, so that one is all the more inclined to regret that all traces of the eastern and western gates referred to by Dr. Bushell have disappeared. The south gate of the city, which is not quite centrally located, had a 10-foot arch according to Dr. Bushell, the present width being about 12 feet and the depth 49 feet. The masonry facing projects beyond the wall line both within and without, the first return occurring some 7 feet from the gate entrance and the second return another 26 feet farther on.

The remainder of the city wall is similar to that already described until the northwest corner is reached, where the original facing exists for considerable distances along both sides of Station 11. When the northern wall joins the back of the King's Palace site it is almost perpendicular, and the facing of the Palace mound projects several feet from the regular line. Here again it is difficult to determine the exact nature of the juncture because of the removal of material. It is interesting to note that much of the wall structure here and elsewhere contains tile of a plain blue or green coloring, seeming to indicate that the Great Khan had his kilns on the site and that the throwouts not used for roofing were dumped into the wall work. The dimensions of the wall on the north side of the city taken at a point 16 feet above present ground level shows a width of approximately 20 feet, the stone facing being set in rough mortar with drainage gullies in the face at various points.

Sites in the Forbidden City

We now turn to a consideration of the various sites (see Fig. 11) in the Forbidden City, which were carefully examined by the writer for any surface indications of building construction, carvings, pottery, etc.

A. Central building indistinct; practically no tiles; those discovered, plain. Built on two levels, main site on 3-foot terrace, the forecourt being 1 foot above surrounding ground level. Two side rooms on forecourt, indistinct. Site contains mixture of blue or gray brick and stone. Surrounding wall to whole site, which showed no china or pottery.

B. Central building similar to A but plainer; stone walls; not much brick on site. Plain tiles and few pieces of red baked tile with green facing. Three rooms on left of forecourt on entering, possibly one on right also. Surrounding wall of stone 3 feet thick. Central block 2 feet above forecourt, which is 2 feet above surrounding ground. Few pieces of coarse pottery and china on site.

C. Building of considerable importance immediately to northwest of gate mentioned by Dr. Bushell, which presumably occupied part of present 60-foot gap. Outer wall of stone; minor buildings outside and to the right on entering, apparently of small importance. Forecourt has two courts at sides and leads to massive gate with gatehouse on either side, dividing wall being 3 feet thick. Gray brick and stone on site, together with some green tile. Inner court same width as the outer one; irregular building on left; courtyards, or walled-in spaces, on right and left continue nearly the whole length of the site. Main building rises 1 foot above court level and has mass of rubble choking the back of it, with some bits of marble and of blue and green tile on the site. Back of this building are curiously distorted mounds of rubble 3 feet high. Small buildings to left rear of block are continued externally to main wall. Apparently rear entrance to main block also. Depres-

sion to right of main building may have been small pond. Well sited outside west wall. Very little china, but carved finials and carved bricks were found on site.

D. Stone outer wall. Forecourt has two courts opening on it, one on left with small buildings, three rooms also on right. Ground rises to inner court about 2½ feet, terraced with rooms right and left. Central building rises another foot and has 2½-foot brick walls. No china visible, but broken green tiles; also yellow and blue moldings, all on red baking. Ground falls sharply at rear to surrounding wall. One piece of good china found outside wall.

E. Few unimportant rooms on the right of approach; main site has high bank all round; wall apparently at top. First rise 5½ feet; steps, if any, not visible. Small buildings to right and left of forecourt. Central building usual open type facing south. The side and rear walls have been partly excavated, probably to enable lamas to obtain brick. No tiles or china found.

F. An irregular group of small buildings on the approach, along center line of Forbidden City; no distinguishing features. No tiles found, but some china. Ground only slightly above surrounding level.

G. This building appears to lie on the junction of roads connecting the gates of the Forbidden City. Site has banking about 5½ feet high, with wall on top. Small building to left rear of main block, which has deep depression in front and slightly to left of it. No tiles or china found.

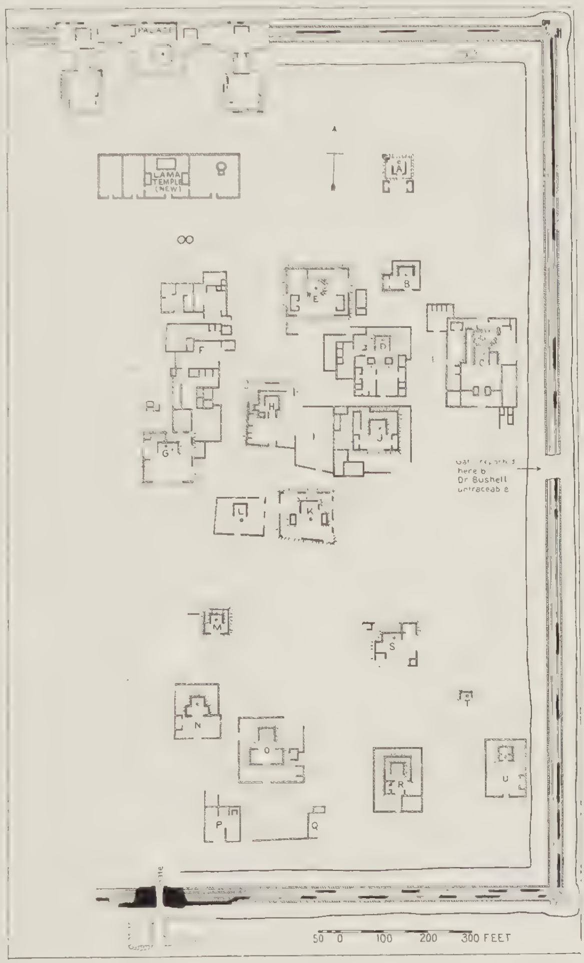

Fig. 11—The eastern half of Shangtu, Forbidden City (cf. Figure 6).

H. Surrounding wall of stone; large forecourt with buildings to right and left of approach to main block, which is 4 feet above surrounding ground. Surface of site very irregular, and back wall of main block partially excavated. Plain and blue tiles found on site.

I. Practically nothing to be seen; may have belonged to either H or J as a garden.

J. Surrounding wall very indistinct to south, apparently had gatehouse. Buildings in forecourt are mainly on west, continuing round to rear of main block. This has a central approach somewhat indistinct and has small rooms to left and right of inner courtyard. The main block looks as if it had two rooms, one with a north entrance, as there is a gap in the inner and outer surrounding walls at this point and a central mound of débris to the

main block. No tiles or china noticeable, but one very large column base to east rear of site. Inner court raised 2 feet, main building another 2 feet higher.

K. Outlines faint; site irregular, 2 feet above ground level, with earth and rubble mounds. Some green tile, considerable gray brick, but no pottery or china.

L. Surrounding wall distinct, but inside only main block visible; almost on outside ground level. Either subsided or not important building. No tiles or china.

M. High mound with wall at slope top, possibly also outer wall not now visible. Site occupied by main block only; some plain tile, some pottery and china. The inner court 3 feet above ground, main block another foot higher. Some large gray bricks on site.

N. Surrounding wall very distinct, with central gate on south. Buildings to left and right of forecourt. Slope up to central block; inner court has small building on right and left. Main block in gray brick, has depression in center. No tiles, pottery, or china visible.

O. Surrounding wall distinct; buildings to east of outer court. Inner court bigger than usual; also has buildings to east and west. Each rise from outer to inner court and to main block about 1½ feet. Piece of gray molding in main block; no china or pottery.

P. Gate to south not central. Main block irregular and covers the rear of site, chief débris being towards the northeast corner, about 2 feet above ground level. No china or tiles; not much brick.

Q. Negligible.

R. Main wall distinct. Buildings in outer court to east, apparently with a surrounding wall. Inner court buildings on west; the surrounding wall continues round main block all the way. Main block of gray brick; some molding on site, also plain tile and china. Depression in center of site; height about 5½ feet above level of outer court.

S. Wall indistinct; building on west of mound and also on center and northeast corner. Ground rises 3 feet, some big slabs of stone on east side of site.

T. Central block only visible; surrounding wall probably submerged, as this land is marshy.

U. Surrounding wall distinct; courtyard has building on east of entrance. Main block about 3 feet above outer court. Stone walls mostly; piece of gray molding and piece of marble on site.

The King's Palace

It may be contended that the writer has taken a liberty in naming the most important site in the Forbidden City. It is because of its importance that he has designated it the "King's Palace." Furthermore, we have the statement of Marco Polo, who tells us that the Khan "erected therein a marvelous palace of marble and other stones, which extends to the wall on one side, and the middle of the city on the other." The site is formed of rammed earth and comprises a central block and two wings, as shown in the plan. It must originally have been faced with brick, for some of this work still remains in situ, being laid in hard mortar. On examining the face of the mound the writer noticed some circular openings which were tenanted by rock pigeons and which he at first presumed to have been made by them. A closer examination, however, revealed that these holes, which are about six to eight feet apart and six or seven feet below the top level of the mound, ran back for a considerable distance into the block. With the aid of a light and a stick the writer found that in several of them were the remains of what seemed to be cedar poles some six inches in diameter, these having dried to the consistency of tinder. Unless they were intended as support to a balcony of some kind the writer is unable to conjecture what could

have been their use. Not that such a construction is usually known in China, but it seems improbable that the poles, which are of a wood not found in northern China, would have been brought thither for an unimportant portion of the building.

The three main blocks of the Palace appear to have been roofed with different colored tiles, for blue, green, and imperial yellow were found on the different sites. A paved yard lay in front of each, and from the fact that the writer found several large pillar bases he would imagine that there was some form of veranda such as is common in the palaces in Peking. It would be interesting to know if there were any dungeons or cellars in the building, for at the present time there are three caves or cellars with arched roofs in the main block base. As far as is known, such a form of architecture was not in use, and the caves may have been excavated since; but, on the other hand, there seems no good reason why they should have been, for not only are they not very habitable but the Mongols always live in *yurts*, while the site of the city, with the exception of the location there of one lamasery, presumably intended to ward off the wandering of the ghosts of the dead, has not been used by them for hundreds of years.

Two other buildings of importance were discovered by the writer in his search for the possible site of another royal palace. Rasr'deddin tells us in his account of the city that the Khan had "another palace in the outer city to the west, of which he was very fond"; and, after examination of all the building sites of importance there, the writer decided in favor of the one shown, which has the largest area and the most massive surrounding wall of all sites in the whole city. All over the surface are to be found bits of broken pottery and china in extraordinary profusion, though unfortunately they are in such small fragments as to have no practical value. The same may be said of all the pieces found in the city, their number being legion; and the writer is of the opinion that they have come to the surface from the action of the thousands of moles working underground and casting out of their tunnels the bits small enough to be moved. If this theory is correct, and there seems no other to fit the circumstances, there must be a treasure of pottery and bronze lying there underground, awaiting only the spade of the scientific excavator. The other site in the northeast corner of the Imperial City shows the same indications to a lesser degree, and the writer would incline to the belief that it is probably a big temple. To the rear of the main building he discovered a stone turtle below the surface of the ground, with the usual slotted back for holding an inscribed tablet; but, unfortunately, the superstitions of the Mongols would not allow him to excavate in the vicinity at that time.

The Treasure Awaiting Excavation

There is no doubt a rich reward awaiting the excavators who can finally overcome the opposition of the natives, either by reasoning or by presents;

for of all the wonders of the city founded by Kublai Khan not a tithe can have been carried away by the Chinese army that finally destroyed the place and overthrew the suzerainty of the Mongols. This is plain from the nature of the struggle, for the Chinese force that pursued the last of the Khans from Peking to Shangtu was mainly infantry; and infantry would loot only such articles as were portable, leaving stones and bronzes alone as being both too heavy and too valueless for transportation. How much of the priceless records which must have existed in the city at that time were destroyed by fire it is difficult to say; but the writer conjectures that, as the walls and roofs were of stone and tile, the fire would be limited, while the collapse of the buildings would cover the contents and protect them to some extent against the ravages of weather and time. If one recalls the recent discoveries of the Russian scientist and explorer Khozlov in Karakorum, one may easily suppose that similar and even greater finds await the patient and enthusiastic seeker in the ruins of Shangtu, and it would be well worth the while of some museum to take up the quest at the point where the author was forced from want of time and money to relinquish it. Not only might this scheme of research be carried out, but explorations might be made eventually to include others of the lost cities of the Khanate, all of which undoubtedly contain valuable historical records.

THE NORSEMEN IN GREENLAND

RECENT DISCOVERIES AT HERJOLFSNES

By William Hovgaard

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It is well known that Icelanders settled in Greenland at the end of the tenth century and established two colonies, the Eastern Settlement, in the southernmost part of Greenland just west of Cape Farewell, and the Western Settlement, about 170 miles up the west coast, in latitude 64° N., at the place where the present colony of Godthaab is now located. Greenland was Christianized early in the eleventh century and in the middle of the twelfth century was brought within the archbishopric of Nidaros, the present Trondhjem. In 1261 the colony, after having existed as a free state for more than two hundred and fifty years, submitted to the crown of Norway, but Greenland had been dependent on Norway economically long before she became dependent politically. The commodities that were most needed, such as iron, timber, and grain, could not be supplied from Iceland; and by submitting to the King of Norway, to whom taxes were henceforth paid, there was a guarantee or probability of a fairly regular connection with Europe. Actually, the Norwegian shipping declined in the thirteenth century through Hanseatic competition; several other causes contributed to make the sailings of the King's ships, the so-called "Knörr," from Bergen to Greenland less frequent, and in 1410 they ceased. From that time on Greenland was, so to speak, a lost country; but its position had been recorded on the map of Claudius Clavus, and old sailing directions from Norway to Greenland were preserved in Icelandic manuscripts. In 1576 Greenland was rediscovered by Frobisher, and in 1721 the missionary Hans Egede arrived—the first European settler after the days of the Norse colony. It was hoped that remains of the Norse colony might still be in existence, but Egede found that it was extinct and that the land was inhabited entirely by Eskimos.

Much doubt has existed as to the ultimate fate of the Norsemen in Greenland. Some have assumed that the colony was exterminated by the Eskimos, and certain accounts in the sagas undoubtedly point in that direction; some have ascribed the disappearance of the Norsemen to a fusion with the more numerous Eskimo population. A third explanation has been offered according to which the colony slowly succumbed through deterioration of vitality. This explanation is confirmed, at least as regards the most southern part of Greenland, by the results of the excavations at Herjolfsnes by a Danish archeological expedition, the work of which is described in this article.

The following account is an abstract and in many parts an extract of three reports, respectively by the leader of the archeological expedition, Dr. Poul Nörlund, of the National Museum in Copenhagen; by Dr. Finnur Jónsson, professor of Norse philology in the University of Copenhagen; and by Dr. F. C. C. Hansen, professor of anatomy in the University of Copenhagen. These reports were made to the "Danish Commission in Charge of Geological and Geographical Survey of Greenland" and were published in *Meddelelser om Grönland*.[1] The facts they bring to light are of the greatest interest both from a historical and from a geographical point of view. The excavations lead to new and unexpected conclusions as regards the fate of this outpost of Western civilization, they yield an absolutely unique collection of original medieval costumes, and they point to important climatic changes in these regions. They also show that communication with the Norse colony continued to a much later date than hitherto supposed.

In the summer of 1921 the expedition under Dr. Nörlund went to Ikigait, where the Norsemen's Herjolfsnes was located and where it was known from former investigations that remains of a medieval Norse settlement existed. The object of the expedition was to examine the ruins, which comprised a church and farmhouses, but more especially to excavate the cemetery, in which coffins and skeletons in shrouds had been found.

Herjolfsnes was named after Herjolf Baardson, one of the followers of Eric the Red, who settled in Greenland in 985. It is situated at the mouth of the beautiful Herjolfsfjord, the present Narssarmiut, near Frederiksdal and not far west of Cape Farewell. Its significance was due to the fact that it was the port of call, or first landing place, in the difficult and dangerous navigation to Greenland. It is proper at this point to note that the Norsemen were the first to sail deliberately and repeatedly across the ocean. Down to that time, as far as known in history, alike in Europe, Africa, and Asia all long-distance navigation had been coastal; but the Norsemen crossed the sea first from Norway to Iceland, then from Iceland to Greenland, and finally directly from Norway to Greenland. This ocean navigation, which incidentally on at least one occasion extended to the American continent, became a regular institution, which lasted nearly four hundred years. Sailing directions were formulated, and experience was handed down from one expedition to the next.

The Excavations

The excavations covered the period from July 5 to August 27, 1921. They began with the ruins of the church and the farmhouses, which had been partly excavated at an earlier date. It was found that the church was

[1] Poul Nörlund: Buried Norsemen at Herjolfsnes: An Archaeological and Historical Study, *Meddelelser om Grönland*, Vol. 67, 1924, pp. 1–270.

Finnur Jónsson: Interpretation of the Runic Inscriptions from Herjolfsnes, *ibid.*, pp. 271–290.

F. C. C. Hansen: Anthropologia medico-historica antiquae I: Herjolfsnes, *ibid.*, pp. 291–547.

FIG. 1

FIG. 2

FIG. 1—Herjolfsfjord, the present Narssarmiut, west of Cape Farewell. This and the following illustrations are from photographs kindly loaned by Dr. Poul Nörlund, National Museum, Copenhagen.

FIG. 2—Herjolfsnes, now called Ikigait, where the excavations took place. The ruins of the church in the center of the picture.

built on the site of a still older church, and evidence of the burial ground belonging to the latter was found in a coffin, the head of which was covered by the foundations of the later structure. Decorations incised on the foot piece of this coffin indicated that the church could not have been built earlier than about 1150, and other evidence seemed to show that it was built about the year 1300.

The excavation of the cemetery was the most important and interesting part of the work. Altogether relics of 110–120 different burials were brought to light in spite of the fact that the southern part of the cemetery, where the richest finds would probably be located, had been washed away by the sea. Only the inferior northern part remained, and the shore line ran close below the south wall of the nave, which had already begun to collapse. The dead were either buried in wooden coffins or laid directly in the earth in the clothes they had worn in life. Probably coffins were used only for people of means, as wood was scarce and expensive. The bodies in the coffins were usually completely decomposed, while in the shrouds skeletal remains were often found.

Christian burial customs were scrupulously observed. The dead bodies were always placed with the head towards the west so that they might face the rising sun when they rose on the Day of Judgment. Great faith was evidently placed in the power of the cross, as shown by the small wooden crosses laid on the breast of the dead. It appears, however, that this custom gradually faded out, for in the later period of the colony crosses became more and more simple or were entirely absent, being symbolized by the crossing of the arms of the body.

The coffins were of extremely simple construction, consisting of a few boards assembled by treenails; the form was trapezoidal, narrow at the foot. A few of them were tied together with whalebone fibers in the way employed by the Eskimos, as was the case in the very early coffin found under the walls of the church. In many cases the lid of the coffin was missing or was crushed in; probably the coffins were often used a second time.

The costumes employed as shrouds were of woven material, generally a four-strand twill. The material was sheep's wool, and the thread was in most cases simply twisted, rarely spun of two yarns. No fur clothing was found, although it is known to have been used; but if used for shrouds it deteriorated completely, as might be expected. Many of the shrouds were threadbare and patched, showing great wear. Darning was apparently unknown.

Numerous examples of loom weights and other spinning and weaving implements, such as occur in the sites of all the old Greenland colonies, were found, testifying to the importance of this industry.

The principal part of the costume was a garment that was generally slipped over the head like a shirt, but some were open in front and provided with buttons. The slip-over dresses were made of two main pieces, a front piece and a back piece, joined by shoulder seams and by side gores. The

sleeves might be short or long. The men's dresses were slightly shorter than those of the women, but otherwise no difference could be detected. In general, sex could only be determined from the skeletal remains found with the costumes.

It is interesting that in none of the costumes from Herjolfsnes is it possible to detect a single special Greenlandic feature. There seems to have been no attempt at adaptation to the arctic climate or to the mountainous nature of the country, nor is there any trace of influence of Eskimo culture.

In cut and style the costumes were an imitation of the European fashions of the day or of a period slightly preceding it. The value of the costumes exhumed at Herjolfsnes is enhanced by the fact that practically no European dresses from that period are elsewhere in existence. As stated above, all the dresses were long; the fashion of a short dress for men, which began in Europe about the middle of the fourteenth century, did not reach Greenland. The style of most of the dresses belongs to the second half of the fourteenth century, but a certain number of fashions from the fifteenth century are also present. Probably there was communication with Europe throughout the fifteenth century, perhaps through Hanseatic or English traders, who intentionally or accidentally landed in Greenland on their voyages to Iceland for dried fish.

FIG. 3—On the left a woman's dress, about the year 1400; on the right, man's dress, fourteenth century.

The headdress was the common medieval hood, which incidentally was well suited to the severe Greenland climate. It was made to pull down over the head, fitted closely around the neck, and had a shorter or longer cape falling down over the shoulders. In front above the forehead it usually projected in a small "horn," because the edge was designed to be turned back from the face. Behind, it had a tail of varying length and breadth. Besides the numerous hoods there were found five round caps of simple cut, with round crown and deep rim, most of them cylindrical. One of the caps, however, was twice as high as the others and of conical shape and is of particular interest as an example of a style which did not appear in Europe until the fifteenth century. It appears, in fact, that this find is among the latest of the articles from Herjolfsnes, for it is unlikely that this fashion could have reached Greenland before the close of the fifteenth century. We have thus a fairly certain indication that intercourse with Europe was

not entirely broken off before that time, that is almost one hundred years later than commonly assumed.

The wooden crosses are also of great interest. Altogether 58 specimens were found, varying greatly in workmanship and design. The ornamentation is simple but always in good taste. On some of them runes are inscribed, often of superior workmanship, clear and accurate, carved with a knife or traced with a needle. The style of the early Middle Ages is predominant, but otherwise the runes give no clue as to date.

Some fragments of drinking and cooking vessels were found, mostly of soapstone. A fragment of a pitcher of Rhenish stoneware gives evidence by its design of communication with Europe in the fifteenth century.

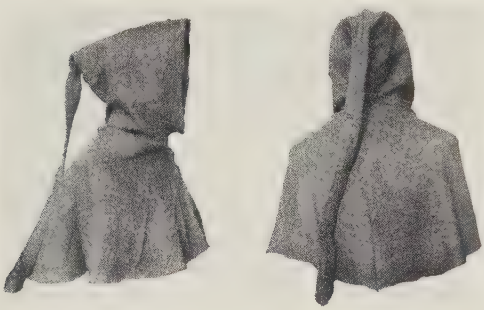

FIG. 4—The characteristic medieval hood was well suited to the severe climate of Greenland.

The work of exhumation and conservation of the articles required the greatest care and skill. Most of the coffins were very fragile, and the costumes that lay directly in the earth were particularly delicate, being saturated with water and having recently thawed. It was decided that the best way to preserve the costumes and the wooden objects on the long voyage to Copenhagen was to pack them firmly in moss saturated with moisture. In this way the objects were kept damp without being excluded from air, and this method proved so successful that when they arrived in Copenhagen three months later they were found to be in exactly the same condition as when packed. The finds filled twelve large cases.

The Inscriptions

The runic inscriptions were interpreted by Professor Finnur Jónsson. The most interesting was that found on a small wooden stick in one of the coffins, reading thus in translation: "This woman, whose name was Gudveg, was laid overboard in the Greenland Sea." Probably this stick was carved in her memory, placed in a coffin, and buried as representing the dead woman.

In 1830 a tombstone was found at Ikigait in an Eskimo hut over a door, where it formed the lintel. It bore the inscription, "Here rests Hroar Kolgrimsson," written in majuscules.

On one of the crosses was found the inscription in runes: "God the Almighty guard Gudleif well." Another cross bore the inscription, likewise in runic characters: "Torleif made this cross in praise and worship of God the Almighty." Several other inscriptions were found, some of them less clear.

The Skeletal Remains

The examination of the skeletal material made by Professor Hansen yielded most valuable information of the build, somatic complexion, life, and diseases of the Norse population of Greenland, information which supplemented that given in the sagas and which could hardly have been obtained in any other way. All skeletal remains, even such as were in a very poor condition, were anatomically examined in the most careful manner. The remains of 25 individuals were examined. The anatomical investigations showed a surprisingly good agreement with the archeological work of Dr. Nörlund as regards the determination of age and sex.

Of the 25 individuals there were 7 adult males, 10 adult females, 4 adults of undetermined sex, and 4 children of 11 to 16 years of age. Ten individuals were between 18 and 25 years of age; the preponderance of the young was striking.

Fig. 5—Carved wooden crosses laid on the breasts of the dead. The largest is about 12 inches in length.

It was found that the stature of the population of Herjolfsnes in later times was in general very short. The three greatest heights were between 5 feet and 5.3 feet, found among the men, while the height of all the women was less than 4¾ feet. Only the most powerfully built woman, who was kyphoscoliotic, could in normal condition have been close to 5 feet high. A conspicuously large number of the women were of slight and feeble build; they were narrow across the shoulders, narrow-chested, and in part narrow at the hips. Several showed symptoms of rachitis, deformity of the pelvis, scoliosis, and great differences in the strength and size of the right and left lower extremities.

From a study of the ages of individuals, already referred to, Professor Hansen infers that the death rate must have been very high, especially among the infants. Of all the individuals over eighteen to twenty years of age, that is four-fifths of the total material, one-half died before their growth was quite completed, i. e. before the thirtieth year, and of these one-fourth died before the twenty-fifth year. Of the individuals who died between the ages of eighteen and thirty years there were twice as many women as men, the cause of which must be sought in the dangers involved by pregnancy and parturition consequent on poor physical development, contraction of the pelvis, and other pathological conditions.

Of twenty-five individuals only five were fairly powerful or well-grown. Of the eight small or slender women five had blemishes or physical defects of various kinds.

The jaws and teeth were on the whole good and powerful although not very large. There were no signs of caries or of loss of teeth by scurvy, but

the teeth showed an abnormal amount of wear. Even in childhood and early youth some of the teeth were worn down to one-half or, in the case of early-cut teeth, even one-fourth of the height of the crown. Comparing their teeth with those of the Eskimos, who live on animal food, it becomes clear that the Norsemen in the later period must have subsisted chiefly on food of a very wearing nature, such as vegetable foods that required a great deal of trituration, probably certain edible lichens and seaweeds and the leaves and bark of certain trees, such as have been used all over the world in times of scarcity and especially in periods of starvation.

Not the least interesting part of Professor Hansen's work is his reconstruction of the profile of the face in the best-preserved male cranium from Ikigait, a process in which he has great experience and by which he had previously produced remarkable results. The elaborate method of anatomical reconstruction is fully described and illustrated, and the resulting profile is of a type well known in northern populations.

The general conclusion from the anatomical investigation is summarized by Professor Hansen as follows:

"The vigorous northern race that originally colonised Greenland degenerated in the course of the centuries under the influence of the hard and at last constantly deteriorating life conditions and other unfavourable conditions, especially isolation, both intellectually, materially and as regards race hygiene. It became a race of small people, little powerful, physically weakened, with many defects and pathologic conditions."

The degeneration in height is "a striking example of the well-known effect of chronic under-nourishment and hard conditions of life on a population, especially on the physical development and stature of the children and younger individuals, when the injurious influence extends to several generations."

"The deterioration of the climate, a higher death-rate among the farm animals, a decrease in the yield of hunting and fishing from several different causes (ice conditions), most probably also competition with the invading Eskimos, have *combined with the decline of the vitality of the population from other causes to form a circulus vitiosus finally involving the extinction of the Norse colonies*, . . ."

We shall here give verbatim the pathetic picture drawn by Professor Hansen of a young woman from Herjolfsnes; her probable appearance, her life, and the fate of her body after death. This description results from a scientific study of the skeleton numbered XX among the finds:

The individual was probably a young woman, perhaps a servant or at any rate without means. She was small, at most 145 cm. of stature, perhaps somewhat shorter; rather narrow across the shoulders and chest and not broad at the hips, on the whole somewhat slenderly built and in her growing days had suffered from some rhachitis. Further, she was knock-kneed, which appeared plainly when she walked or ran. Her ankles were thick and clumsy. The right leg, though of the same length as the left, was somewhat thinner and feebler. In the left knee she had recently begun to get a little arthritis, and at times it hurt somewhat on the inside. Her head was small, the forehead low, the eye-sockets small,

the face rather large though without prominent cheek bones, but the jaws were short and powerful, and the masticatory muscles strong. Her teeth had been good enough but were now much worn, so that the lower portion of the face had become shortened, but it was no wonder for as a general rule she had to be content with plain, tough, and often even bad and little nourishing fare and be thankful too. She was somewhat better off for clothes for she spun much wool year in, year out, and sometimes had some of her master's or mistress's discarded clothing given to her, for there was not much difference then between a man's and a woman's dress. She was fairly strong for the muscles of her arms were well-developed and had to work much, but her arms had little by little become curiously slanting from the elbows, and it did not look nice when the forearms and the coarse clumsy hands rough with work actually projected from her body when she turned the palms of her hands forward. Otherwise it was not very noticeable, particularly when the arms were bent at the elbows or hung down along the sides with the palms turned towards the thighs.

When she was 25 years old or thereabouts her life came to an end. Like the other inhabitants of the settlement she never grew old, life in the severe cold of these regions had gradually become too hard to live. She died and was buried in her old patched clothes directly in the damp earth, for the times when coffins could be provided for people of her sort were long since past. During the short summer in the churchyard the plants still sent their roots deep down into the soil, so that living roots at last grew all through the clothes and the dead human bodies, penetrating even into the most delicate pores of the bones, while the acid humous substances of the soil slowly and gently dissolved the hard lime of the skeleton, at the same time tanning and preserving the soft organic connective tissue substance. Some lime was, however, left, and the enamel of the teeth was too solid to be quite dissolved, it remained hard, only growing still more brittle than before.

At that period, several years or even a short lifetime later, the cold had gradually grown so severe that the earth only thawed for a shorter and shorter time each summer. At last the earth froze permanently round the body in the lower part of the grave, while the upper part of the grave still thawed for a short time every year. Finally the grave with its contents froze to the bottom and never thawed again, so that all that was still left of the bodies of the dead, the skeletons penetrated by plant roots, and the clothing in which they were encased, the simple wooden crosses which accompanied them in their graves, all was preserved unchanged for 500 years.

The Deterioration in the Climate

Perhaps the most important cause of the decline and final extinction of the Norse colony in Greenland was the deterioration in the climatic conditions to which reference has been made several times.

When the Norse Greenlanders first settled, they brought with them cattle and sheep, which are known to have been successfully reared during the first centuries of the existence of the colony. In the "King's Mirror"[2] we read: "It is reported that the pasturage is good and that there are large and fine farms in Greenland. The farmers raise cattle and sheep in large numbers and make butter and cheese in great quantities." They even attempted to raise grain. At present it would be impossible to obtain sufficient winter fodder for herds of cattle. In fact, cattle are found in only one place. To grow grain would be quite hopeless.

Old records mention an increase in the masses of ice that drift along the coast; and it is difficult to understand how the early Norse settlers were

[2] Speculum regale, transl. by L. M. Larsen, American Scandinavian Foundation, New York, 1917.

able to sail to and from South Greenland if the ice conditions were as bad as they are now.

The migrations of the Eskimos point in the same direction. According to Dr. Nörlund the Eskimos follow the seal, which prefer moveable ice; they cannot exist on ice-free coasts. When the Norsemen settled in Greenland they found trace of the Eskimos, who evidently had lived there but had again migrated to the north. In the thirteenth century, however, they reappeared and advanced persistently southward until finally, by the middle of the fourteenth century, they had occupied the Western Settlement, which apparently they destroyed. One or two centuries later they inhabited the entire west coast down to Cape Farewell. Dr. Nörlund believes that only fluctuations in the ice conditions can explain these migrations.

The most conclusive argument in favor of the increased severity of the climate is the fact that the wooden objects and woven costumes in the cemetery of Herjolfsnes were preserved for some five hundred years. The nature of the soil cannot account for this, as the soil was gravel and sand, which has small preservative power; but all the well preserved finds were exhumed from layers that at the present time are frozen all the year round, and we may safely conclude that this determined their preservation. Yet these objects must have been buried under conditions where the soil was thawed, at least at midsummer. All but one of the costumes, even the very deepest-lying, and many of the coffins were pierced by and matted with the roots of plants, a fact that cannot be explained otherwise than by their having been in a thawed condition when this occurred. Hence the only explanation is that the climate became more and more severe.

No quite satisfactory explanation has been found of this change in climate; perhaps the best is that given by the Swedish geophysicist and hydrographer Professor O. Petterson,[3] who ascribes it to periodic variations in the combined attraction of the sun and the moon. This attraction is greatest during the coincidence designated as a perihelion-node-apside, in which both sun and moon reach their closest proximity to the earth and maximum of declination. This coincidence occurs about each 1850th year. It occurred last in the year 1433 A. D. and before that about 350 or 400 B. C. It causes violent fluctuations in the tides, results in destructive bores, and would, according to Professor Petterson, cause the ice masses of the Arctic to break up and drift southwards, entailing great changes in climatic conditions of the arctic and subarctic regions. This theory seems to be supported by various occurrences in Scandinavia and northern Asia but cannot be said to be quite substantiated.

Professor Petterson's explanation apparently fails to account for the fact that ice conditions seem to be at least as bad at the present time as they were in the fifteenth century. If the change in climate were due to cosmic periodically recurring events, as he suggests, we might expect that

[3] See the review of his paper "Innere Bewegungen in den Zwischenschichten des Meeres und der Atmosphäre," in this number of the *Geogr. Rev.*

the ice conditions, having reached their maximum of intensity about the year 1400, would, during the following 500 years thereafter, show a marked improvement, since 500 years is nearly one-third of the period of time indicated by him.

Whatever be the explanation of the change in climate, there can be no doubt that it did actually take place, and it seems likely to have been caused by or at least associated with a change in ice conditions. It follows that the surrounding regions of land and sea must also have been affected, and it would be interesting to know whether such a change can be traced with certainty in Iceland and whether perhaps it contributed to the decline in prosperity and vigor of the population of that island which took place at the end of the Middle Ages.

In Flóamanna Saga it is related that an Icelander, Thorgils Orrabeinsfóstri, sailed from Faxafjord in Iceland to Greenland, probably in the year 998[4]. After having drifted about on the sea for several months, the ship stranded on the east coast of Greenland and broke in two. The shipwrecked people lived for two years at the bay where they stranded, being unable to get away on account of the dense masses of ice that drifted past outside, almost incessantly barring the entrance. Finally they built a skin boat and worked their way south along the coast, but on this voyage they suffered the greatest hardships and did not reach Ericsfjord until about two years later. This account would seem to indicate that ice conditions about the year 1000 were already very bad, but perhaps the place where Thorgils stranded was very far to the north, even beyond Angmagssalik. The long time occupied on the voyage to Ericsfjord and the fact that Eskimos were met with on several occasions point in this direction, for it is known that no Eskimos were found in South Greenland at that time, while they may have existed at Angmagssalik.

Relations with Eskimos

By the year 1400 the Eskimos had probably advanced southward along the west coast as far as the Eastern Settlement, and the relations between them and the Norsemen were not altogether friendly, judging from the report of the destruction of the Western Settlement and later Eskimo tales and traditions. Nothing has come to light in the excavations of Herjolfsnes pointing to an intermingling of the two races, nor is there any indication in the finds of that locality that the Norsemen imitated or adopted the Eskimo culture, as suggested by Dr. Nansen. It seems indeed reasonable to conjecture that the Norsemen, when they were cut off from Europe, would adopt a civilization so perfectly suited to the arctic environment and, in particular, that they would take up the Eskimo mode of hunting the seal. That this did not actually occur at Herjolfsnes may perhaps be explained

[4] William Hovgaard: The Voyages of the Norsemen to America (Scandinavian Monographs, Vol. 1), New York, 1914, p. 69.

by the fact that at that time the Norsemen were in an extremely enfeebled condition, which rendered them unfit for the difficult task of building and handling kayaks, the skin boats of the Eskimos, as well as for the use of Eskimo weapons and the hardships of their life of hunting.

The End

The noted Icelandic author Björn Jónsson of Skardsaa wrote in 1625 of "an Icelander named Jón Greenlander who within 'living memory' had related how he had once been blown off his course and come to Greenland on board a German merchantman. According to computation it may be assumed to have occurred about 1540. The ship entered a fiord with many islands. Several of them were inhabited (probably by Eskimos). These they dared not, however, approach, but went ashore on a small uninhabited island where there were boathouses and stone walls quite like those in common use in Iceland. 'There they found a dead man lying prone. On his head he had a well-made hood, his other clothing being partly of frieze partly of sealskin. By his side lay a bent sheath-knife much worn and wasted by repeated whetting. This knife they took away with them as a souvenir.' "

Dr. Nörlund adds: "It is hard to know how truthful a witness Jón Greenlander was, but his account bears throughout the stamp of credibility. It represents to me a most tragic picture of the end as I believe we must most probably imagine it. The last Norseman, clad in a dress like those now found at Herjolfsnes, lying dead and unburied by his desolate and deserted dwelling and holding in his hand the emblem of the cultural superiority of the European, the iron knife which had been ground and ground to the extreme verge of possibility. And when that verge was reached the European succumbed and the hardy Eskimos, the small Arctic race adapted to the physical conditions, took possession of the land by the right of the strongest."

While it seems certain that the end of the colony at Herjolfsnes was substantially as described by Dr. Nörlund and Professor Hansen, it does not necessarily follow that events took the same course at other parts of the widely scattered settlements. Herjolfsnes was situated at the extreme wing of the Eastern Settlement, and with the poor means of communication available in later times, especially the absence of good boats, the small population was probably in an isolated position. It is not impossible that the larger settlements at Gardar on Ericsfjord and elsewhere may have fared better and may have endured longer than at Herjolfsfjord. It may be that intermingling with the Eskimos has occurred. At any rate, until it has been proved by further investigations that conditions similar to those at Herjolfsnes existed elsewhere, it seems unsafe to generalize from the sole experience at that small outlying settlement.

THE TOPOGRAPHY OF THE AMAZON VALLEY

By C. F. Marbut and C. B. Manifold

U. S. Department of Agriculture

[With separate map, Pl. V, facing p. 642]

In a region like the Amazon valley opportunity for travel is presented mainly by the rivers. On account, however, of the activity of the rubber gatherers for the last two or three decades the rubber-growing regions have been traversed in all directions by trails. This is especially true of the upper Purús, the Acre Territory, and the upper Juruá country. Elsewhere trails are few, running from the navigable rivers only short distances into the country. The passable trails as a whole are fewer now than formerly. For example the maps show a long trail extending from Labrea on the Purús southward to the Campos country, lying between the Aquiry and the Madeira, which is reported impassable because of fallen bridges. The road from Riberalta, Bolivia, to the Mamoré River opposite Guajará-mirim is reported impassable also. The same is true doubtless of many others because of the decline in the rubber industry, though it is still sufficiently important in the Acre-upper Purús-upper Juruá country to keep the trails open.

The data set forth in this article[1] were collected by the authors during travel by various means—on the rivers by steamboat or launch, rarely by canoe, on land by horse or mule, and on the Madeira-Mamoré and Bragança railways. Short trips were made on foot. Some information was obtained regarding regions not reached by either of the authors from residents and traders along the route; and the literature, so far as it concerns the special features discussed in this paper, has been carefully examined.

The Inner Amazon Basin

The area discussed may be called the Inner Amazon Basin. It is concerned mainly with the region of unconsolidated sands and clays colored as Miocene and Quaternary on Branner's[2] geological map of Brazil and country of the same general character in eastern Peru and northeastern Bolivia.

The area extends from Bragança, about 100 miles east of Pará, to the Pongo de Manseriche on the Marañon River in Peru—a distance of about

[1] The objective was the Crude Rubber Survey of the U. S. Department of Commerce, August, 1923, to May, 1924. See also W. L. Schurz: The Distribution of Population in the Amazon Valley, *Geogr. Rev.*, Vol. 15, 1925, pp. 206–225.

[2] Mappa Geologico do Brazil, accompanying the article by J. C. Branner: Outlines of the Geology of Brazil to Accompany the Geologic Map of Brazil, *Bull. Geol. Soc. of America*, Vol. 30, 1919, pp. 189–337.

2200 miles. Its width varies greatly: it is shaped like a spatula. A line across it at its widest point, along the 68th degree of longitude, is about 800 miles long; and across the handle of the spatula, in the longitude of Santarém, it is not more than 200 miles.

This great area is a broad, shallow trough with the Amazon River lying, presumably, along the bottom but in an unsymmetrical position with respect to the northern and southern boundaries, i. e. nearer its northern than southern side.

The south-bank tributaries of the Amazon are longer than those of the north bank, and their courses lie at a higher angle with that of the main stream, making the belt drained by them much wider than that of the north-bank streams. The basins of the south-bank tributaries are also unsymmetrical, their right-bank tributaries being longer and larger than those of the left bank. This is true, however, only of those right-bank tributaries of the Amazon the axes of whose basins lie at an angle smaller than 90 degrees with the axis of the main stream. The basins of the right-angled tributaries are approximately symmetrical.

Geological History

It is not necessary to discuss the details of the geology of the region or of its geological history. A general outline of its history, accepting the work of Katzer[3] as the most authoritative, is about as follows.

The older Tertiary rocks lie along the lower Amazon, and the younger in the upper part of the basin; after the deposition of the older beds the lower Amazon region was raised above the sea. The Andes Mountains were uplifted long after the lower Amazon region was uplifted; and, from the time when the latter uplift took place until the uplift of the Andes had made considerable progress, the drainage of what is now the Inner Amazon Basin was westward into the Pacific. With the uplift of the Andes the westward outlet was closed, and for a period of undetermined length the upper basin existed as an enclosed sea receiving the drainage of the surrounding country. An undetermined thickness of the sands and clays constituting the deposits of the upper basin was laid down during this time. With the progressive uplift of the Andes and the filling of this inland basin the drainage was finally turned eastward, and the Amazon River came into existence. The belt of Quaternary deposits shown on the Branner geological map seems to be based mainly on the work of Katzer and includes the existing flood plain of the Amazon and some of its tributaries and also, as will be seen below, belts several miles in width on one or both sides of the river that at the present time constitute true upland. No attempt will be made in this paper to differentiate between this Quaternary upland and the upland on the Miocene beds. Katzer[4] states that the

[3] Friedrich Katzer: Grundzüge der Geologie des unteren Amazonasgebietes, Leipzig, 1903, pp. 239–262.
[4] Katzer, *op. cit.*, p. 108.

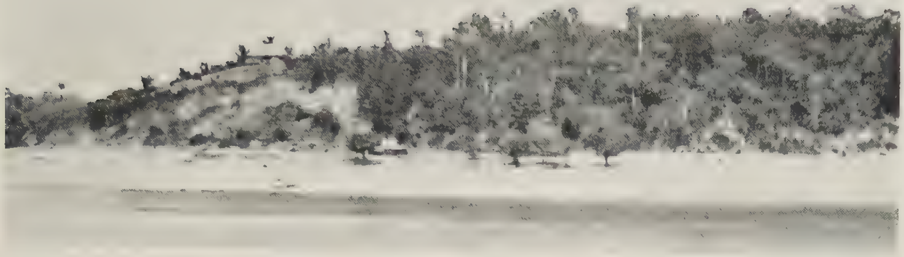

FIG. 1

FIG. 2

FIG. 3

FIG. 1—Bluff two miles below Manáos. (Photograph by C. F. Marbut.)
FIG. 2—Bluff on the Solimões at Fonte Bõa. (Photograph by Dr. Avelino de Oliveira.)
FIG. 3—Bluff at Parintíns. (Photograph by C. F. Marbut.)

Tertiary deposits of the lower Amazon do not differ petrographically from the Quaternary deposits in the same region; and, since neither consists of marine deposits and both are young, they do not seem to differ paleontologically, though Katzer is silent on that point. He bases his differentiation on the uniformity in facies of the Tertiary over a large area and presumably, though he does not say so in so many words, on the lack of this uniformity of the Quaternary deposits. He states that the two deposits cannot be sharply differentiated. He described the thick deposits of which the prominent mesas lying on both sides of the river between Parintíns and the mouth of the Xingú are built up as late Tertiary in age. They constitute, in his opinion, remnants of the deposits made in the lakes existing in this region between the time when the original westward drainage was blocked by the rising Andes and the newly formed Amazon had become definitely established. These mesas rise to nearly a thousand feet above sea level and several hundred feet above the general level of the uplands around them. If the deposits of which they are remnants are of very late Tertiary age and were made immediately before the development of the Amazon River it is evident that the erosion which has reduced the surrounding country and isolated them as remnants has been performed by the Amazon itself and not by such streams as may have drained this region westward before the birth of that river. If this be the case the Amazon River cannot be considered, at least in its lower course, a young river still seeking a place where it may develop a valley. The region cannot be considered a *terra immatura*.

The Valleys

The valley of the Amazon River below the Pongo de Manseriche in Peru and those of all its tributaries lying within the region of unconsolidated rocks are well graded, have normally developed profiles of equilibrium, and in all respects are like those of streams in an early mature stage of development wherever they may be found. The valleys are in no apparent sense unique except in the mere matter of the size of the master stream. There seems to be no indication that the stages through which the various streams of the area have passed to reach their present maturity have been marked by any unusual occurrences. The flood plains are broad, and their cross sections are in every way normal. Along the immediate stream banks the natural levee is well developed, and the texture of the alluvium is relatively light. It is narrower than the natural levee along the banks of the Mississippi, and the material is heavier than that along the latter stream.

The back swamp is in every way as characteristically developed as on the lower Mississippi. On the Amazon it is often treeless, while on the lower Mississippi this is rarely or never true; though on the upper Mississippi treeless areas with heavy soils are of rather common occurrence. On the Amazon it is flooded for a longer period than the natural levee, water stands

on it for a longer time, and after the flood has subsided it contains many lakes, some of which are permanent.

It does not follow, however, that the channel of the Amazon is as free from islands as that of the Mississippi or that the alluvial plain is free from lakes and sloughs. The map (Pl. V, facing p. 642) shows that the channel has many islands and that the back swamp has many lakes and sloughs, the *paranás* and *furos*. Their existence, however, does not imply a less mature stage of development in valley building than that of the lower Mississippi nor does it imply the absence of the marks of this maturity.

The presence of such a great number of lakes and sloughs in the Amazon valley is possibly due to the annual inundation and to the finer-grained load carried by the river as compared with the lower Mississippi. The Mississippi tends to maintain a natural levee but slightly higher than the back swamp, and the Amazon tends to keep the low parts of the back swamp filled with water. Whatever the cause, the lakes and sloughs cannot be considered as evidences of an immature stage of valley development. No measurements of differences of elevation between the natural levee and the back swamp were made. It is unnecessary to describe them in greater detail since no contribution was made by the expedition to the knowledge of these features. Their identity with such features on all large rivers in comparable stages of development is evident. They have been fully described by Le Cointe.[5]

It is apparent that the region around the mouth of the Amazon has been somewhat depressed in recent geological time. The river not only has no delta, but the tide is felt as far up as Obidos, more than 600 miles by water from Pará. Since, however, there is at no time during the day, at least above the head of the island of Marajó, a reversal of the downstream current it does not follow that mean low water at Obidos is equivalent to low tide or mean tide in the Atlantic.

No one will be surprised at the statement that such elevations of points along the Amazon as are given in the literature are of doubtful accuracy. No line of spirit levels, much less of precise levels, has even been run up the river. The only determinations that have been made are barometric; and, where differences in elevation between places, even those many miles apart, are as small as they are on the Amazon, such determinations must be made with extreme care if they are to have any value. There seems to be no available information regarding the care with which observations on the Amazon have been made.

Le Cointe makes very few statements about elevations. The elevation of the port of Manáos is given as 26 meters, but the exact point whose elevation was determined is not described. The elevation of Pebas on the Marañon in Peru is given as 105 meters, but the exact spot referred to is not given. A rather large number of elevations is shown on the Amazon

[5] Paul Le Cointe: L'Amazonie brésilienne: Le pays—ses habitants, ses ressources, notes et statistiques jusqu' en 1920 (2 vols., Paris, 1922), Vol. 1, pp. 148–181; Vol. 2, pp. 54–92.

River charts published by the U. S. Hydrographic Office in 1882. While the observation spot in all cases is marked on the map its position is not described; and the reader, even though familiar with the local topography, in most cases is unable to determine definitely whether the spot lies on top of a low bluff, on a slope, or at some stage of the water in the river.

The Alluvial Plain

Notwithstanding the existence of a great deal of definite information regarding the width of the Amazon flood plain, much popular misconception still prevails. On account of the dense forest cover and the lack of roads, travel has been performed from the earliest days by boat. The traveler sees high land but a few times between Pará and Manáos, or even well up into Peru. He more or less unconsciously thinks of these points of upland as islands in an otherwise boundless area of lowland submerged during high water. Another factor accounting for popular misconceptions is the misuse of terms in describing the geological deposits of the Inner Amazon basin. It is practically universal for German and English writers at least to describe the unconsolidated sands and clays underlying the uplands of the Amazon region as *alluvial deposits*. The broad use of this expression does not differentiate the uplands from the true alluvial lowlands of the valley proper; and the matter is not cleared up and held consistently clear by even the most authoritative recent publications. Even Le Cointe in his general discussion seems to imply that the area flooded annually is much larger than it is, although a careful reading of his detailed descriptions and his large-scale map of the lower Amazon[6] show with great accuracy the width of the true alluvial belt below Manáos.

Denis is the most extravagant of all in his description of the immense area subjected to annual inundation: "A vast wilderness, almost absolutely level, with a few hills of granite strewn upon its surface; low-lying plains covered by annual inundations; dry land rarely advancing as far as the river's banks. . . ."[7] On the other hand, the true width of the valley from Manáos to Gurupá was shown on a small-scale map by Smith[8] as early as 1878. In one or two particulars, especially in the vicinity of Parintíns, he seems to be more accurate than Le Cointe.

As will be shown below, the valley, or flood plain, of the Amazon is narrower than that of the Mississippi between Cairo, Ill., and Baton Rouge, La., and its boundaries with the upland are just as well defined. No attempt will be made to describe in detail the width of the valley below Manáos since it is so well done by Le Cointe and Smith. Only a few localities where the evidence points to a somewhat different conclusion from that shown by Le Cointe's map will be mentioned.

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[6] Paul Le Cointe: Carte du cours de l'Amazone depuis l'océan jusqu' à Manaos et de la Guyane brésilienne, 1:2,000,000, *Ann. de Geogr.*, Vol. 16, 1907, Pl. IV.

[7] Pierre Denis: Brazil, London, 1911, p. 357.

[8] Herbert H. Smith: Brazil: The Amazons and the Coast, New York, 1879 (map as frontispiece).

The map, Plate V, facing p. 642,[9] shows the width of the Amazon and its tributaries in so far as existing knowledge will permit. From Manáos to the mouth the data for the width of the belt are taken, with few exceptions mentioned below, from Le Cointe's map. Elsewhere the width of alluvial plains as shown is based on data obtained by the authors.

The tidal stream on which the city of Pará (Belem) is situated is not flanked by alluvial lands; the upland on the island of Marajó and that on the mainland from Pará to the Atlantic form the banks of the stream. Above Pará the channel through which up-river traffic passes flows between low alluvial banks except in a few cases. A detailed description of the intricate network of channels, alluvial islands, and occasional upland remnants would be unwarranted in a general paper even if our knowledge were complete.

It will be noted that the western part of the island of Marajó is alluvial and the eastern part upland, the termination of the upland along the southeastern side of the island being at Ponta de Pedras. West of this for a considerable distance the river bank is alluvial. A small remnant of upland presents a site for the village of Curralinho, another one for Brèves, and still another for the shipping station of Antonio Lemos. Smith[10] states that the whole of the island of Marajó is alluvial except a fringe along the south and east sides. He does not discuss the matter further, but it is apparent that he had in mind this western part of the island and that there are probably other remnants of upland than the three just mentioned. It is probable that Boa Vista stands on one; though no stop was made at the place by the Commission, and no definite information was obtained. There seems to be no definite information regarding the upland south of the river, but evidently the upland there exists only as rather narrow strips between the valleys of the numerous parallel rivers, all of considerable size, that drain the country for a long distance to the south. It is probable that Portel stands on an upland fragment, as well as Melgaço.

It is also probable that the western part of the island of Marajó, shown as alluvial, has a number of small remnants of upland similar to that at Brèves scattered over it, each one being a fragment of an upland ridge between the northerly flowing parallel streams south of the channel which formerly discharged into the Amazon on the north side of this belt, now designated as alluvial. Le Cointe's postulation of a similar course for the Tocantíns is possibly correct but seems to stand on somewhat less convincing evidence than does the case for these smaller streams. The main channel of the Amazon lying north of the island of Marajó is not bordered by an alluvial plain. The large islands in the mouth of the river, Mexiana and Caviana, are mainly upland islands similar to Marajó.

The first point at which the true width of the river valley may be seen, unmodified by valleys of tributary streams is opposite the village of Gurupá.

[9] M. Le Cointe's valuable map (footnote 6) has been especially used as a base for the relative portion of the map whence longitude is shown west of Paris.

[10] *Op. cit.*, p. 88.

FIG. 4—Bluff on the Purús near Ipiranga. (Photograph by C. F. Marbut.)

The village stands on upland, though there seems to be no evidence as to a continuity with the upland east of the Xingú south of the village; but it is assumed to be the northern point of the upland separating the valley of the Xingú from that of the Anapú.[11] Le Cointe gives its elevation above the highest flood level as about 20 feet. The width of the alluvial plain opposite Gurupá is about 20 miles.

Opposite Santarém the apparent width of the valley is much less than below or above this point. Le Cointe gives its width as 25 kilometers (16 miles). He measures it from the south side of an isolated upland island standing in the flood plain. The true width should, however, be measured by the distance from Santarém to the upland east of Alemquer and north of the island: thus measured the width is a little more than 20 miles.

Le Cointe shows the entire island of Tupinambarana, extending from Ideal on the Madeira River to the outlet of the Paraná de Canumá below Parintíns, as alluvial land. The site of Parintíns was visited by the Commission and proved to be on an upland identical in character and elevation with that at Gurupá. No opportunity was presented for an examination beyond the site of the village. A visit was made to the island at Tabocal southeast of Itacoatiára, and it was found that the river washes the foot of a well defined upland for a few miles. The elevation ranges from 25 to about 40 feet above high water, and the upland is well dissected as far as can be seen from the top of the bluff. The Pinto map of the Amazon[12] published by the Brazilian Government in 1866 shows a bluff along the river a few miles below Tabocal extending intermittently for several miles. The existence of a number of houses in this stretch tends to confirm the identification of this as upland. The island was visited by the Commission at Ideal, at its extreme southwestern end, where it consists of undulating upland some 30 feet higher than high water in the Madeira. At a point

[11] This point, all the island of Marajó, the Pará-Bragança region, and most of the upland touched by the river below Manáos are mapped as Quaternary by Branner. The determination of age is accepted as correct; but the maturity of this upland, assuming that this may be measured by the mature character of its soil cover, is essentially like that of the Tertiary rocks. It is *true upland* even though it may have been river alluvium at some previous time.

[12] Carta particular do Rio Amazonas, pelo Sr. José Soares Pinto, Capitão Tenente D. A. N. J., nos annos de 1862 a 1864.

FIG. 5—Bluff at Labrea, River Purús. (Photograph by Dr. Avelino de Oliveira.)

about 40 miles below Maués on the Paraná de Canumá a point of low upland was identified by the authors on the left bank of the Paraná, and finally Brown[13] shows a strip of upland along the axis of the island on his map of the lower Amazon. This island seems to be the product of the interaction of streams—the Madeira and Canumá—whose valleys were parallel and not far apart.

The width of the valley opposite Obidos is about 20 miles; opposite Parintíns it is about 30 miles; between Itacoatiára and the bluff on the south side of the valley at Tabocal the distance is only 10 miles. Itacoatiára and Tabocal are both on well defined upland, a few feet higher in both cases than at Parintíns. The valley here is unusually narrow and much narrower than at any point below. The rocks on the north side of the river at Itacoatiára are no more resistant, indeed are seemingly somewhat less so, than at Parintíns, and those on the south side are less resistant than at Itacoatiára. The situation is so unusual as to require explanation. Published accounts seem to offer no satisfactory explanation, and the Commission had no opportunity to study the region. There is one suggestion, however, that offers a possible solution. The Urubú River lies a short distance north of Itacoatiára, flowing eastward after having approached to within a few miles of the Amazon a short distance west of the town. Some 30 miles above Itacoatiára a *furo* runs from the Amazon eastward and enters the channel of the Urubú River. This rather strongly suggests the existence of a valley extending from the Amazon above Itacoatiára eastward, including the valley of the Urubú River, and opening into the Amazon below Itacoatiára. This may be a former course of the Amazon at a time when the Madeira occupied the valley south of Itacoatiára now occupied by the Amazon and the two rivers united below that town instead of above it as at present. If this be the history of development of this locality the width of the Amazon valley is to be measured from the north bank of the river valley southward to Tabocal, a width of 30 miles.

There seem to be no unusual features in the valley from this point for

[13] C. Barrington Brown: On the Ancient River Deposit of the Amazon, *Quart. Journ. Geol. Soc.*, London, Vol. 35, pp. 763–777.

several miles, according to the observations of the authors confirmed by the Amazon River Chart No. 892 of the U. S. Hydrographic Office.

The Madeira River Valley

The width of the Madeira valley between Ideal and the mouth of the Aripuana (Roosevelt) River is apparently very irregular. At the first right-hand bend below the mouth of the Aripuana the valley is less than three miles in width, and at Borba it is no more than that.

Between Rosarinho and Borba, a distance of about 60 miles, the river does not touch the left-bank upland, according to the maps of the Amazon River published in 1882 by the U. S. Hydrographic Office. This stretch was passed at night by the Commission, and no observations were made; but no reference has been found in the literature to the occurrence of any upland along the river in this stretch.

The first point above Ideal where the right-bank upland is seen is Caisara, about 30 miles above the head of the Paraná de Canumá. The Caisara bluff is continuous, with insignificant interruptions, with the right-bank bluff at Borba, about 16 miles farther upstream.

The left-bank bluff is washed by the river at Urucurituba about 15 miles below Rosarinho.

At Borba, however, the situation is unusual, on account of the restriction of the width of the valley to less than three miles. The presence of houses and fields on all the presumed upland behind the bluff lines as shown on the map lends probability to the accuracy of the identification of the bluffs as those of real upland. The map (Pl. V) shows another bluff on the left bank about ten miles above the bluff opposite Borba and another on the right bank about ten miles still farther. If there be no mistake in the identification of the upland on either side of the river, the Madeira valley is only about three miles wide for a considerable stretch. This we shall see is unusually narrow; but the narrowness appears not to be due to geological conditions, since there is no evidence that the rocks along this stretch are different from those in other places on the lower river. About 30 miles above Marepethi the river washes the bluff on the right bank at Sapucaiaroca at the mouth of the Jacaré River. This place also was passed by the Commission during the night, but from Vista Alegre to Itapinima the trip was made in daylight. Without detailed description it may be stated that there can be no question concerning the existence of upland at all points indicated between these places and that the identification of upland by the authors is in agreement in general with the charts of the U. S. Hydrographic Office.

The width of the valley below the mouth of the Aripuana (Roosevelt) River aswell as at Borba is undoubtedly too small to be regarded as the normal width of the Madeira, assuming that no mistake has been made in the identification of the upland. Such restrictions in the width of the valleys

of large rivers are by no means unknown. The explanation when not due to the presence of resistant rocks usually lies in the occupation, by a main stream, of the valley of a tributary for a greater or less distance above the point where the two streams united before the occupation. A number of cases have been described from the Mississippi system.[14] There are two groups of conditions in the region of the lower Madeira that suggest the possibility of a shift of the Madeira channel from a former course parallel with and to the northwest of its present course. One of these is the series of bluffs, as already noted, suggesting a valley width from Borba to Itapinima entirely too narrow for a stream as large as the Madeira; and the other is the Autas River, lake, and *furo*. The observations of the authors indicate that lakes on the uplands in the Amazon valley are extremely rare or wholly absent. Le Cointe's[15] upland (*terre firme*) lakes do not lie on the upland but in the valleys of small streams tributary to the lower Amazon just above where they open into the Amazon flood plain. They are identical features with the lakes along the Red River in Louisiana.

The Autas River valley was not visited, and no information whatever was obtained concerning it. The large lake in the valley is entirely too far away from the junction of the river with the Amazon to justify its explanation as a *terre firme* lake.

The most probable explanation is that it is a flood-plain (*varzea*) lake lying in a valley of abnormal width for the present stream. The Autas *furo* joins the Autas lake with the Madeira above Borba. It is difficult to see how such a channel could have been cut across the ridge between the two streams. A possible explanation is that the Madeira from above the mouth of the Aripuana originally flowed in a valley parallel with its present valley and on the north side of it and that the Autas River from the Autas lake or possibly above the lake down to its junction with the Amazon occupies this former valley of the Madeira. The Aripuana then flowed into the Amazon below the mouth of the Madeira along the valley now occupied by the Madeira. Through sidewise sapping of the upland between the two rivers they cut it away for a stretch of several miles above where Rosarinho is located and later at other points higher up and finally in the vicinity of the present mouth of the Aripuana. The Madeira occupied the Aripuana valley when it cut away the upland between them.

While this is based wholly on circumstantial evidence it offers a possible explanation of the facts.

The relation of the Madeira valley to that of the Paraná de Canumá through which a part of the Madeira reaches the Amazon a long distance below the principal mouth, is easily explained by the sapping of the narrow ridge separating the parallel streams.

Above the mouth of the Aripuana the valley is maintained apparently at a relatively uniform width. Between Manicoré and Democracia, both

[14] C. F. Marbut: Cote Sans Dessein and Grand Tower, *Amer. Geologist*, Vol. 21, 1898, pp. 86–90.

[15] L'Amazonie brésilienne, Vol. 1, p. 155.

on well defined upland, the width is relatively narrow but not narrow enough to require explanation. In all cases the upland above Manicoré was identified as such by the authors. It differs in a few points from the upland locations shown on the charts of the U. S. Hydrographic Office. In many places along the river the alluvial lands are high and have been mistaken apparently by the hydrographers for upland. All those high alluvial lands are subject to overflow, but the period during which they are flooded is

FIG. 6—Bluff on the Amazon half a mile below Obidos. (Photograph by C. F. Marbut.)

short. The soil profiles beneath such lands show them to have assumed the characteristics, though less strongly expressed, of upland soils.

From Santo Antonio to Guajará-mirim the Madeira runs over a series of rapids and low falls. There is no continuous belt of alluvium within this stretch. Above Guajará-mirim, however, there are broad belts along the Mamoré and also along the main tributary, the Guaporé. The width of these belts was not determined.

Beni, Madre de Dios, and Abuná Rivers

The only waterfall or rapid on the Beni system after its rivers leave the Andes is at Cachuela Esperanza some ten miles above its junction with the Mamoré at Villa Bella. Above the Cachuela the river winds through a relatively broad flood plain. The flood-plain boundaries are sharp, and the river wanders from one side to the other, the upland being washed by the river on one side or the other at intervals usually of ten miles or less.

No surveys were made of the river channel. The location of the river and its meandering course is accepted as shown on a map prepared by the

Bolivian military engineers[16] this being the one from which its course has been taken for the map (Pl. V). The width of the flood plain seems to be about seven miles up to Riberalta. The Beni above Riberalta was not visited, but the Madre de Dios was followed to Sena about a hundred miles, in a straight line, above Riberalta. The alluvial plain of the Madre de Dios up to this point is as wide as that of the Beni below Riberalta. There seems to have been no invasion of the valleys of parallel rivers

FIG. 7—Low upland at Codajaz, Solimões River. (Photograph by Dr. Avelino de Oliveira.)

in the Beni basin similar to that on the Amazon and Madeira. The rivers are smaller, and the upland is higher.

The Abuná River was ascended from its mouth to São Luiz in the Acre Territory. It has a strongly meandering course above the Cachoeira Fortaleza, about ten miles above its mouth. On a river trip of 240 miles from the mouth the upland was seen at about a hundred places.

THE ACRE-PURÚS VALLEY AND THE JURUÁ

At Cobija in eastern Bolivia the Acre is but little more than 120 feet wide; but it is navigable for small gasoline launches even in low water, and in high water river steamers reach the town with ease. The alluvial belt is narrow; but a low belt, seemingly a terrace, has a width of a little more than a mile. At Itú the belt flooded at high water is very narrow, but the low terrace-like belt is fully a mile wide. At Rio Branco the flooded belt ranges up to a quarter of a mile, but low terrace extends eastward on the east side of the river for somewhat more than a mile. A short distance

[16] F. M. Rivera: Mappa del territorio de colonias del noroeste, 1:1,000,000, Comisión Topográfica Milítar, Cobija, 1922.

below Rio Branco the flood plain belt widens, though the low terrace-like land is seen at many places along the river as far down as Floriáno Peixoto.

The Purús above the mouth of the Acre was not visited. Below it the river meanders through a flood plain of considerable width, and according to reliable information the same condition exists farther upstream. Like the Acre, Abuná, and Juruá Rivers the upper Purús region is well known up to and even beyond where the river becomes too shallow for small launches.

The flood plain seems to present no unusual features, though there has apparently been some invasion of the valleys of parallel streams by flood-plain widening. The most evident case is in the vicinity of the mouth of the Tapauá.

The Juruá River was not visited. The geology of the region through which it flows seems to be exactly like that along the Purús. The course of the river as it is shown on the best maps available is in details essentially like that of the Purús. The country on both sides of the upper part of the river was, during the period when the rubber-gathering industry was active, one of the best of the rubber fields of the Amazon basin, standing next to the Purús as a producer. None of the literature describes the width of the valley or even mentions the localities where the river washes upland bluffs. The number of rubber stations shown on the best maps usually located at the extremities of river meanders on both sides of the stream make it extremely probable that they are located on upland and that a line, as in the case of the Purús, touching the oxbow extremities on both sides of the river would show approximately the bluff lines and the width of the valley.

The Solimões

Above the mouth of the Rio Negro the axial stream of the Amazon basin up to Tabatinga is called the Solimões; above that, the Marañon.

According to existing maps the width of the alluvial plain throughout the course of this river from where it leaves the Andes and enters the great Amazonian plain to the mouth of the Negro varies greatly and, according to this supposed width, may be divided into three stretches. From a short distance above the mouth of the Negro to a few miles above Manacapurú the plain seems to be about as wide as just below the mouth. The river touches the upland at a number of places in the north side of the valley, but the bluff on the south side seems not to have been defined. From the upper end of this stretch upstream to the outlet of the Paraná Avati a broad belt of alluvium is shown on all the Amazon maps. It has an average width of nearly 75 miles and is traversed in all directions by a number of *paranás* and *furos* communicating with the Solimões at one end and the Japurá at the other.

This region was not examined except for such observations as a steamer trip afforded. The stopping places, with a very few exceptions, are all on

the south side of the river, partly because the river touches the upland at many points on this side and partly because the rubber country lies almost wholly south of the river and the large tributaries through which this country is reached enter on this side.

The village of Codajaz on the north side of the river, located within the belt shown as alluvium on Amazon River maps, stands on a low area of upland apparently similar in character to the low upland on which the villages of Gurupá, Parintíns, and S. José stand. It is true upland at present. The profile of the soil covering it shows unmistakably that it has long been subjected to weathering and has received no river deposits on its surface. It is possible or even probable that it is a terrace remnant.

FIG. 8—Tapajóz River at flood stage with upland, near Aveiro. (Photograph by C. B. Manifold.)

Whether the long stretch of supposed alluvial land lying north of the Amazon channel west of this contains other areas of this kind or whether it contains isolated islands of still higher upland is not known. It is probable that such areas exist and in considerable number, as is indicated by an examination of the parallel courses of the Solimões and the Japurá from the entrance of the *paraná* down to its true junction with the Amazon. The area on which Codajaz stands is probably such a remnant.

A glance at any of the recently published maps of the Amazon basin shows the completeness of the drainage system. Many of the drainage lines are imperfectly located, but the upper part of the basin, especially the basins of the Madeira, Beni, Purús, and Juruá, have been penetrated in every direction during the last quarter of a century by rubber gatherers, and existing maps are based on information from these sources. While these streams have not been located by actual instrumental surveys, they are known to exist and their locations are approximately accurate. It is well known that such a drainage system cannot develop in a country covered with swamps. The existence of a well developed all-penetrating dendritic drainage system in any region is unmistakable testimony of the absence of swamps and lakes.

The Upland Drainage

The drainage net as shown on Plate V is copied mainly from the Millionth Map of Brazil for the region west of Manáos, and for the region east of Manáos from Le Cointe's large map.[17] A few changes have been made on the basis of information obtained by the members of the Rubber Commission, mainly from Sr. Monteiro da Costa, a member of the Brazilian part of the Commission. The Pixuna and Mucuim Rivers, between the Purús and the Madeira, are shown heading farther south and west than on any map of Brazil hitherto published. The position of the Iquiry, around its source and as far as the crossing of the trail from São Luiz to Rio Branco, has been shifted nearer to the Acre than on published maps. Some minor details of drainage have been added along the São Luiz-Rio Branco trail; and the drainage around the head of the Marmellos and the Machado, tributaries of the Madeira, has been reconstructed.

Many lakes are shown at considerable distances from all the large rivers. It is apparent that in most if not in all these cases they are flood-plain lakes whose locations have been reported by fishermen, hunters, rubber or nut gatherers. They usually report them as lying so many hours by canoe from the river. The slough connecting them with the river is characteristically crooked, but the map maker seems to have measured the distances to those lakes at right angles to the main river rather than at a low angle. The same statement applies to the courses of small streams also.

The Upland

The total area of recently deposited alluvium in that part of the Amazon basin occupied by unconsolidated deposits of Tertiary age approximates 120,000 square miles. The total area of this part of the whole basin is about 1,200,000 square miles. The alluvial land subjected to periodic flooding, usually though not in every case annual in occurrence, constitutes therefore about 10 per cent of the whole area of the region.

While the upland as a whole is low it is by no means flat. In all that part visited by the Commission it must be described as a well dissected undulating to rolling plain naturally well drained. According to information obtained from rubber gatherers the greater part of the region not visited by the Commission is of the same general character. Most of the region was visited during the dry season though by no means all of it, the Solimões, Marañon, and other parts of eastern Peru and the Tapajóz, Xingú, and Tocantíns regions having been visited in the height of the rainy season. In that part of the region visited during the dry season the character of the soil showed unmistakably that it had not been subjected during its development to the influence of excessive soil moisture. It exhibited those features universally recognized as the product of normal good drainage in soils as fully developed as those of our own coastal plain.

[17] See footnotes 6 and 9.

The area may be broadly subdivided into two plains, an upper and a lower. The lower lies along the rivers approximately in the axial belt of the river basin. The upper occupies the rest of the region. The lower plain seems to correspond approximately, from the mouth of the Madeira downstream, to the region mapped by Branner[18] as Pleistocene. A region above the mouth of the Madeira that seems to be part of this plain is crossed by the Purús below the mouth of the Tapauá, and at least a part of the broad belt of low country between the Solimões and the lower Japurá belongs to a low plain. This is undoubtedly true of the low upland at Codajaz, and the belt probably contains other areas of the same kind.

The Lower, or Marajó Plain

The lower plain, which will be designated the Marajó plain, covers all the upland portion of the islands of Marajó, Mexiana, and Caviana, the mainland south and east of the Pará River as far eastward as the Atlantic at Bragança and southward up the Tocantíns to a point 25 miles north of Baião, a strip of country on both sides of the Tapajóz and Xingú, a large part of the "island" of Tupinambarana, and the upland along the lower Madeira and the north bank of the Amazon for a few miles west of Itacoatiára. The area corresponds approximately to the upland portion of the area shown on the Branner geological map of Brazil as Quaternary below Tonantins.

The region around Pará, including the islands, and the country along the lower Tapajóz and Mojú consists of a smooth plain standing 25 to probably a maximum of 50 feet above mean tide. Between Pará and Bragança it is smooth but well enough dissected to afford good surface drainage in most places. One small area a few miles east of Castanhal station is flat and poorly drained. The surface of the island of Marajó seems to be flatter than most of the area, but the greater part of it is rolling enough to be free from large areas of standing water during the rainy season.

The village of Gurupá stands about 25 feet above high water, according to Le Cointe;[19] and presumably other parts of what seems to be an extension of the plain southwestward along the east bank of the Xingú are of about equal elevation. A bench extends along the Tapajóz on both sides of the river for some distance above its mouth. At Boim it is nearly eight miles wide, and south of Santarém it seems to be of about the same width. It is described by Smith,[20] but its width is not given.

Branner represents the whole of the island of Tupinambarana as Pleistocene and to this extent identifies it as part of the Marajó plain. The northeastern end at Parintíns has the same general character and about the same elevation above high water (25 feet) as the Marajó plain at Gurupá. The upper end of the island, south of the Furo de Ramos at Tabocal, is several

[18] See footnote 2.

[19] L'Amazonie brésilienne, Vol. 1, p. 75.

[20] *Op. cit.*, pp. 135–175.

feet higher than at Parintíns, standing some 40 feet above high water, and has apparently a more rolling surface. The surface here is also much less sandy in character than at the places already described. At Ideal on the Madeira the upland seems to be higher also than at Parintíns though not enough of it was seen to warrant a definite conclusion.

On the west side of the lower Madeira, however, at and below Rosarinho the upland seems to be like that at Parintíns; and the same is to be said of the low upland at San José on the north bank of the Amazon west of Itacoatiára.

The plain on which Codajaz stands is apparently a fragment of the Marajó plain, and what seems to be a low belt along the Purús below the mouth of the Tapauá may also be a part of it. At none of the places, either on the lower Madeira or west of it, are these low areas sandy. They all have a clay soil and subsoil.

The upland at Borba, Manicoré, and Democracia is low but somewhat higher apparently than the general level of the Marajó plain along the Amazon proper, and for this reason this part of the upland is included within the area of the higher plain.

The Higher Plain

The higher plain varies both in character of relief and in elevation from place to place. Nothing more is known of it east of the Xingú than that it extends along the east side of the river for some distance and along both sides of the Tocantíns and presumably occupies the country between these streams. Between the Xingú and the Tapajóz a smooth-topped plateau rises rather abruptly from the Marajó plain a few miles south of Santarém. Smith[21] describes its abrupt rise and mentions its smooth top, but he does not estimate its elevation above Santarém. Katzer[22] gives the elevation of the top of a ridge dropping abruptly at its northern end to the Amazon a few miles east of Santarém as 80 meters. This is presumably the plateau described by Smith. This seems to be merely the northern end of a smooth upland that extends southward for a long distance, presumably to the southern limit of the Tertiary deposits. The bluff at the north end of the ridge is the most prominent topographic feature to be seen on the south side of the river below Santarém. Katzer states that the northern end of the plateau a few miles southeast of Santarém attains rapidly an altitude of about 200 meters and that the top rises slowly southward to about 300 meters a hundred miles or more from the Amazon. Within the area of the Tertiary deposits it probably does not rise much above 200 meters. East of this ridge, which does not seem to extend to the east of the Curuá River, Katzer says the rise from the south bank is gradual but says nothing about the elevation that is finally attained.

[21] *Ibid.*, p. 144.
[22] *Op. cit.*, p. 67.

FIG. 9

FIG. 10

FIG 9—Upland at junction of Javary and Solimões Rivers. (Photograph by Dr. Avelino de Oliveira.)
FIG. 10—Upland, northern part of Manáos, looking northwest. (Photograph by C. F. Marbut.)

The upland on the west side of the Xingú River at Souzel rises abruptly to an elevation of about 40 meters. The topography on the upland and the character of the soil are similar to these features on the plateau south of Santarém. This seems to extend southward to Victoria where it drops to the low undulating plain occupying the great bend in the Xingú between Fort Ambé and Victoria. The first high land seen on the west side of the Xingú lies about 25 miles above Porto de Moz. It is about 100 feet high and is evidently a part of the plateau noted at Souzel and at Victoria. It is apparent that the upland along the Xingú below Victoria is an eastward extension of that south of Santarém; but it is lower, indicating a slope eastward.

The same upland, or what seems to be the same, lies along both sides of the Tocantíns. At Cametá the upland seems to be part of the Marajó plain since it is only about 20 feet high. At Baião, and for several miles above and below, the upland lies a little less than 100 feet above the river. At Alcobaça there is a low bench of about 25 feet and a narrow strip of upland above it; beyond this mile-wide strip the upland plateau rises to nearly 100 feet above the river. West of the Tapajóz a number of plateau fragments rise to a maximum elevation, according to Le Cointe, of 152 meters within a very short distance from the river. The two most important are the Serra Parintíns and the Serra Balaio.

Since the upland on the west side of the Tapajóz for a considerable distance both to the north and the south of Itaituba is low and no highland is visible to the westward from the village it is apparent that the high plateau whose fragments have been described above does not extend southward into this region although it lies across the river east of Itaituba. It seems probable that the high country on the lower Tapajóz and east of Parintíns is a feature of the Tertiary deposits and that the southern boundary of this formation is marked by a southward-facing escarpment.

Very little is known of the character of the upland southwest from Parintíns. In the vicinity of Maués the prevailing upland belongs to the Marajó plain. About 50 miles below Maués the upland along the east bank of the Paraná de Canumá is about 75 feet high. It is in sight at several places below this and does not vary much from this elevation. South of Maués the elevation stands at about 50 feet for a distance of at least 40 miles, the highest point reached by the Commission; and residents report that bluffs 100 feet and more in height are first seen on the river about 80 to 100 miles above Maués. Presumably these higher bluffs are still within the Tertiary.

On the north bank of the Amazon from a short distance west of Obidos eastward to some distance beyond Almeirim there are a number of plateau remnants, constituting, with the exception of the hills at Monte Alegre, the most prominent topographic features visible from the river. The most westerly group lies between the Jamunda and Trombetas Rivers a few miles from the Amazon. Another group lies north of Obidos. The mesas of the

group between the Trombetas and Jamunda are a little less than 200 meters high, according to Katzer,[23] while the elevation of the group north of Obidos is about 150 meters. These are probably remnants of an old plain originally continuous with the one whose remnants lie around the mouth of the Tapajóz and westward to Parintíns. A description by Katzer[24] indicates that these hills stand well above the forested country lying north of them. Since, according to Branner's map, they must lie on or near the northern border of the Tertiary deposits it is apparent that these beds terminate in a northward-facing escarpment and maintain the characteristic plateau-like upland and a considerable thickness of beds up to the boundary.

The hills in the region around Monte Alegre are, according to Katzer, built of Carboniferous rocks. They rise higher than those around the mouth of the Trombetas, attaining a maximum elevation of about 350 meters according to Le Cointe, and have a less pronounced mesa-like character than the hills described above.

From a short distance northeast of Prainha eastward to within a short distance of the Jary river is a string of hills—about 235 feet high, according to Katzer—presenting strikingly well formed mesa-like characteristics when seen from the Amazon. The most westerly, the Serra do Paranaquará, seems to stand as an isolated mass, according to an illustration by Katzer;[25] but there seems to be no definite information in existence regarding the relation of its upland surface to that of the Tertiary country north of it. It is surrounded on the west, north, and east by the valley of the Jutahy and on the south by that of the Amazon though Smith[26] states that this and the other mesas of Tertiary rocks to the east stand on or rise from a low upland and not from the Amazon flood plain. It is evident from an inspection of Le Cointe's map[27] that he regards the Serra do Paranaquará (360 meters) as a part of a plateau of equal altitude lying to the north, isolated by the valley of the Rio Jutahy, and that the group of similar hills to the eastward consists merely of the southern ragged edge of this plateau where it drops to the valleys of the Amazon and the Parú.

It would seem that these plateau fragments are parts of an original plain and that the varying elevations are due to earth movements. The hard layer capping the plateaus is not a geological formation but a bed of accumulated iron oxide due to soil development. Its occurrence in two places, therefore, does not prove that the two beds are of the same geological age though both must have been in existence for a considerable time. In no other part of the central Amazon basin is the upland so high above the local drainage, and it is probable that it nowhere else attains an equal absolute height unless it be near the mountains.

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[23] *Ibid.*, p. 4.
[24] *Ibid.*, p. 4.
[25] *Ibid.*, p. 7.
[26] *Op. cit.*, p. 631.
[27] See footnote 6.

On the Madeira and Abuná

The upper plain, or what we have identified as such, is rather low on the Madeira below the mouth of the Aripuana (Roosevelt) River. At Ideal it stands some 30 feet above high water and about the same at Itapinima, Manicoré, and Democracia. At the last-named place it seems to be a little higher, standing at 40 to 50 feet above high water. At Humayta it is about 60 feet, at Calama nearly 100 feet, at Porto Velho somewhat over 100 feet

Fig. 11—Recent clearing eight miles south of Cobija, Bolivia. (Photograph by C. F. Marbut.)

above high water and seems to lie at about this elevation between Porto Velho and Guajará-mirim. Although Branner's geological map shows crystalline rocks at Porto Velho (near S. Antonio) and thence inland from the river, yet all the upland from a mile back of the town to a distance of at least four miles is capped with material differing in no way, according to a rather superficial examination, from the unconsolidated rocks along the river below. Wherever the railway reaches the upland a few miles from the river the deposits seem to consist of unconsolidated sands and clays usually more sandy than below the mouth of the Machado. The railway runs over the upland a few miles south of the village of Abuná, and the cuts near the top do not expose crystalline rock. On the Pacanovo, a stream flowing into the Mamoré from the east a few miles above Guajará-mirim, crystalline rocks are exposed in a number of places in the river channel, but the bluffs consist of unconsolidated sands and clays or of iron oxide masses. The material is very sandy throughout all the Pacanovo valley. The upland is usually low, rarely rising more than 60 feet above high water, but the bluffs are well defined.

The upland rises as the Beni and Madre de Dios are ascended. At Riberalta it stands about 90 feet above the river and at Sena a little more than

100. The upland surface was examined at Riberalta, Sena, and Conquista and seen at many other places. At each place it is rolling.

On the Abuná the upland is invariably undulating to rolling. The maximum elevation above the river was somewhat more than 100 feet. In several places it ranged between 20 and 50 feet above high water.

From São Luiz, a rubber-shipping station on the river about 240 miles from the mouth, an overland trip was made to the Acre River about ten

FIG. 12—Upland five miles southwest of Yurimaguas, Peru. (Photograph by Dr. Avelino de Oliveira.)

miles below Rio Branco, a distance of some 60 miles. The trip was made at the end of October after the rains had begun. The small streams were still in low-water stage; but the Iquiry was in low-flood stage, and the Acre and Abuná had both begun to rise. During the first five hours of the trip a rolling country, well dissected to a depth of a little more than 60 feet was passed over. Its freedom from excessive moisture at any time was shown by its well oxidized soils and the abundance of rubber trees (*Hevea brasiliensis*). During the next two hours the country traversed was less rolling but still free from any suggestion of swamp. During the last hour and a half before camp was made, 25 miles from the start, the topography was rolling and much like the first stretch. On the second day a like distance was covered. The first three miles was over rolling land, the rest over smooth land across shallow ravines ranging up to a maximum of 40 feet in depth with gentle slopes as a rule. The soil showed signs of slightly imperfect drainage but complete absence of swamps even along the ravines. The abundance of Brazil nut trees indicated fair freedom from excess moisture, but the scarcity of Hevea an unfavorable condition for that tree.

The Iquiry River was reached at night, the descent from the low upland on the south side being very gradual. On the north side the rise is quite abrupt, and the height of the top above the river is about 140 feet. The rest of the trip to the Acre, about 15 miles, was over rolling country. The upland immediately along the Acre River lies about 75 feet above the flood plain.

FIG. 13—Topographic sketch along the northern half of the cart road from Cobija to Porvenir. Cobija is situated approximately in latitude 11° S. and longitude 68° 54′ W. (Greenwich).

On the Acre

The narrow alluvial plain of the Acre at Rio Branco is bounded on the east side by a belt of low upland apparently not more than two or three miles wide. The true upland, lying close to the river on the west bank, is rolling with a local relief of about 100 feet or a little more. The upland from Rio Branco up river to about 20 miles above Xapury is low, in most places ranging between 15 and 40 feet above maximum high water. At a few places, however, higher land is touched by the river; but throughout the distance higher land seems to lie but a few miles away. At Itú it begins less than four miles southwest of the river. It continues thence southeastward for at least 25 miles as a rolling upland with a local relief within the Acre River drainage of about 100 feet and around the head of the Iquiry of about 50 or 60 feet. In the whole region there is no suggestion of swamps or even of imperfect drainage except in the belt lying between the river and the edge of the higher upland. A few miles above Porvir the upland on the west bank rises in two benches. The lower stands some 60 feet above high water and is but a few yards wide, while the upper rises to more than 100 feet above the river. From the top the same upland level on the east

side of the river is in sight a mile away or less. It is apparent that this is the general level of the upland southward for many miles and probably the same as that east of Itú and possibly that on the west bank of the Iquiry east of Rio Branco.

Above Porvir there seems to be no well defined low upland bench along the Acre. At Cobija the upland lies more than 100 feet above the river. The accompanying topographic sketch (Fig. 13) of a strip of country lying along the northern half of the cart road from Cobija to Porvenir is illustrative. As a whole this area is somewhat more deeply dissected than most of the region visited. The region west of Rio Branco and along the trail between São Luiz on the Abuná and the Acre River, the Beni and Madre de Dios region, and the Abuná and Purús regions are as *completely* dissected as this, but the *depth* of dissection probably ranges from about two-thirds to a half of what it is here.

Below Rio Branco the modern alluvial plain is, like that above the town, very narrow. The upland is at first low, ranging below 40 feet above high water, and is nearly flat near the river. It is probably a continuation of the up-river terrace or terrace-like upland. At Bom Destino this bench is about 35 feet above high water, but at Porto Acre the bluff is about 100 feet high. At Boa Vista, however, the upland is again only about 30 feet above high water, indicating that the higher upland at Porto Acre is not part of the terrace-like bench. Nova Andirá is 35 or 40 feet above high water, and a point on the same bank less than ten miles below is about 50 feet. At Porto Central the upland is about 100 feet above the river and at Floriáno Peixoto fully as high; but at Santa Rita, the only place where upland was seen between Floriáno Peixoto and the mouth of the Acre, the town stands on a bench 20 feet above high water. At the mouth of the Acre the upland on the west bank of the Purús is fully 150 feet above high water; and at Monte Verde, some eight or ten miles below, as well as at the mouth of the Inauhiny it is about the same in height or possibly a little higher than at the latter place. Between this point and the mouth of the Purús upland was seen at about 46 places. During the last two days travel was continued through the night, and it is probable that one or more upland points were passed.

The upland from the mouth of the Inauhiny to a point a short distance below the mouth of the Tapauá, except a stretch above and below Labrea, averages about 100 feet above high water or possibly somewhat more. Thence to a point a few miles above Ipiranga it ranges from about 25 feet above high water down to a very few feet. Below this point it is higher again, being about 80 feet in the vicinity of Ipiranga but apparently becoming lower northward. In the vicinity of Labrea the upland is less than 60 feet above high water, but the character of the country at some distance inland could not be determined. The fact that from Nova Olinda southward the country is rather well netted with trails and that the whole region is shown covered by a network of streams indicates that it is well dissected.

In what seems to be a low belt crossed by the river between Nova Olinda and Ipiranga there is doubtless some poorly drained country.

On the Solimões

From a few miles above the mouth of the Rio Negro to a point a short distance west of Manacapurú, upland lies almost continuously along the north bank of the river. It averages 40 to 75 feet above flood-plain level. Above this stretch the river banks are alluvial on both sides until Codajaz is approached, and the upland here is but a few feet higher than high-water level. It is reported that at flood stage the village site becomes a small island. The Pinto map of the Amazon River indicates an upland bluff along the north bank of the river for nearly ten miles below Codajaz, but if it exists it is even less conspicuous than the Codajaz bluff. The same map shows bluffs at several points above Codajaz also, but no such spots of upland were noted by the authors.

Well defined upland on the south bank of the river is touched for the first time at Mamia where it stands about 30 feet above water. From this point to the mouth of the Jutahy the right bank of the river consists of upland bluffs, or the upland lies not far away.

At Coary and for a considerable stretch below the village the upland rises immediately from the river to a height of about 50 feet above high water. Where it approaches the river west of the mouth of Coary River at Santa Cruz de Barro Alto it stands at about the same height and continues thence to Ipixuna and the mouth of the Catuá River.

The character of the country south of the river from its mouth up to the Catuá could not be determined, but west of this lies a dissected plateau that seems to extend at least as far as São Paulo de Olivença. It is dissected by the Teffé, Juruá, and Jutahy Rivers and their tributaries and is reported to have a rolling topography. It stands at least 100 feet above high water and is touched by the river in the form of prominent bluffs at Nova Planeta, Caiambé, San Izidoro, and São Paulo de Olivença. At intermediate points the immediate bluffs are lower, but in many cases the country rises within a short distance from the river to the plateau level.

Upstream from a short distance below Tonantins the flood plain is relatively narrow, and upland is washed by the river at many places on both sides of the valley. In general the bluffs are not so high as at São Paulo de Olivença. No definite information concerning the elevation of the upland at some distance from the river was obtained except that, between the Huallaga River at San Antonio de Yonayaco and the Ucayali due east of this point, the upland crossed by the Commission did not reach an estimated elevation of as much as 100 feet above the rivers but was thoroughly dissected and well drained. It was apparent, on approaching the ridge traversed by the Pongo de Manseriche water gap, that the upland became a little higher and a little more rolling than farther east.

THE QUESTION OF PEARY CHANNEL

By Lauge Koch

The question of the Peary Channel has in the course of time called forth a whole literature, and as there now exists a definitive map of the regions that Peary assumed to be traversed by a channel, I shall try to explain the errors that have accumulated in process of time concerning this problem. There is the more reason to do so, since we owe it to the memory of Peary to meet the attacks that have been directed against him with regard to his explorations in North Greenland.

It seems most natural to commence with a survey of the literature dealing with Peary's journey in 1892 and by means of this to show what Peary really saw and mapped and what he only imagined he saw.

On Peary's return from his expedition he published in the New York *Sun* (Sept. 12, 1892) a letter dated St. Johns, Newfoundland, September 11, in which the channel is not mentioned. This letter was reprinted in the *Journal of the American Geographical Society*.[1] In the same volume of the *Journal* is found an address by Peary,[2] in which (p. 542) he says:

> . . . the entrance of a large Fjord came into view in the northwest, and soon after the land rose into view north and northeast *with the depression of the Fjord beyond it*.[3] I then deflected my course to the east, and soon found the land *and the Fjord beyond it*[3] again confronting me; deflecting still more, this time to the southeast, I advanced until the first of July, when a broad break in the land beyond the Fjord was visible opening out to the northeast, and I immediately made for the land with the intention of reaching this opening.

This quotation shows how much Peary saw from the ice cap. Concerning the view from Navy Cliff he writes (p. 543):

> To our left lay the depression of the Fjord which had barred our passage, and still farther to the northward we could make out the entrance of a second Fjord, reaching apparently to the northwestward.

These statements were published in the year of his return. At the same time Robert N. Keely and G. G. Davis of the relief expedition, whose information was based on Peary's account of the journey, expressed the idea of a channel thus:

> In the north was seen the mouth of a fjord reaching from the face of the glacier back into the land in a westerly direction, and probably connecting with Victoria Inlet.[4]

In 1893 we have another account by Peary in which he says:

> . . . we continued our march, always northeastward, till on the 27th of June I discerned black mountain-summits rising above the horizon of the ice-cap, directly ahead

[1] Mr. Peary's Return from Greenland, *Journ. Amer. Geogr. Soc.*, Vol. 24, 1892, pp. 470–473.

[2] R. E. Peary: The North Greenland Expedition of 1891–92, *ibid.*, pp. 536–558.

[3] The italics are mine.

[4] R. N. Keely and G. G. Davis: In Arctic Seas: The Voyage of the *Kite* with the Peary Expedition, Philadelphia, 1892, p. 395.

Fig. 1 Peary's Map, 1892

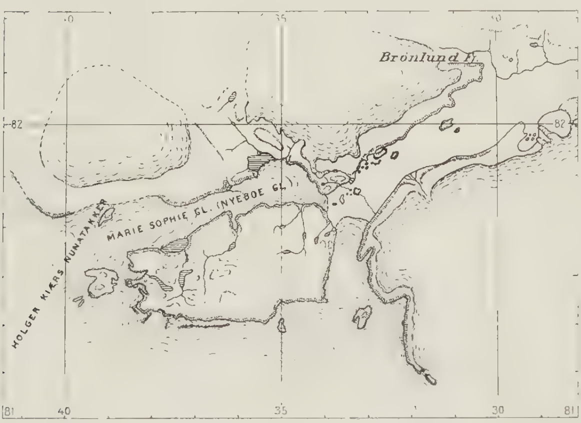

Fig. 2 Rasmussen and Freuchen's Map, 1912

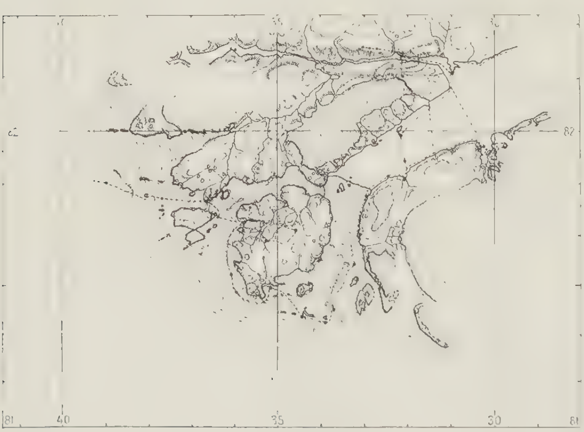
Fig 3 Lauge Koch's Map, 1921

of us. Then the northwest entrance of a fjord came into view, *and we could trace its course southeasterly just beyond the nearer mountains of the land north and northeast.*[5] I changed my course to east, when I was soon confronted by the land and the fjord beyond. Then I turned to the southeast, and traveled in that direction until the 1st of July.[6]

The same year a weighty article by Cyrus C. Adams was published in the *Geographical Journal.* The writer stated that he had access to "the entire series of notebooks kept by Mr. Peary . . . , and, with the consent of the explorer, he has prepared this statement of some phases of the work." Mr. Adams says:

He was able to make out both shores of Victoria Inlet in the neighbourhood of its entrance into Lincoln Sea. He traced the higher mountains that border the northern side of the channel all along from Lincoln Sea to Independence Bay. He was unable, at his distance from the western edge of the ice, to see the southern border of the channel between 45° and 40° W. long.; but in his march along the edge of the ice-cap to the southeast he

[5] The italics are mine.

[6] Josephine Diebitsch-Peary: My Arctic Journal: A Year Among Ice-Fields and Eskimos, With an Account of the Great White Journey Across Greenland by Robert E. Peary, New York and Philadelphia, 1893, p. 226.

was able now and then to see the channel through rifts in the mountains that border it. He has no doubt that he has traced the northern border of the mainland and established the insularity of Greenland.[7]

In 1898 Peary's great report on the journey was at last published. Herein he writes:

> Our next march to the south-east was a short one, only ten miles, and nearly parallel with the land. Dark-brown and red cliffs looked down into a grand vertical-walled cañon reaching up towards our camp and everywhere north-west, north, and east, black and dark-red precipices, deep valleys, mountains capped with cloud-shadowed domes of ice, stretched away in a wild panorama. . . .[8]

Referring to the view from Navy Cliff he says:

> Looking to the west, we saw the opening of the fjord that had barred our northern advance. It was this fjord whose western entrance we had descried afar off days before. Now we knew that we had paralleled its course across the northern end of the mainland from Robeson Channel clear to the Arctic Ocean off the shores of north-east Greenland. For days we had kept constantly in view the mountain masses forming the southern boundary of this channel, and through rifts in the mountains we had from time to time seen this depression, and had now and then caught glimpses of the frozen channel occupying it; and we had seen beyond it mountains and fjords stretching between them. It was evident that this channel marked the northern boundary of the mainland of Greenland.[9]

This is all the information given by Peary as to his conjecture of a channel. It will now be interesting to see on Figure 3 where he traveled. We know, from his address[10] and from Mr. Adams' article,[11] that during the journey on the ice cap no astronomical observations were made. Peary traveled by means of an odometer, and only at four camps on the outward journey and three on the return was the position determined by means of astronomical observations. The only cartographic station during the journey was Navy Cliff, where Peary took theodolite observations, the results of which were published for the first time with the address.[12] Thus the map of the Peary Channel is based only on rough sketches. However, it would seem that one of the camps, the position of which has been determined by astronomical observations, is situated in about latitude 82° N. and longitude 40° W. From this camp Peary looked across the great ice-free land that now bears his name and realized that he was standing near the northeastern boundary of the ice cap. He must have had a wide view across a broad plateau traversed by great canyons and deep valleys, and he supposed that he was gazing upon "an archipelago whose western limits Lockwood had discovered in 1882."[13]

Just in front of him Peary saw a great glacier descending into a deep valley, and it seemed to him as if the valley opened out into a sound, covered with level sea ice. During the journey to the southeast Peary passed an-

[7] Cyrus C. Adams: Lieutenant Peary's Arctic Work, *Geogr. Journ.*, Vol. 2, 1893, pp. 303–316; reference on p. 310.

[8] R. E. Peary: Northward Over the "Great Ice," 2 vols., New York, 1898; reference in Vol. 1, p. 318.

[9] *Op. cit.*, pp. 345–346.

[10] See footnote 1.

[11] See footnote 7.

[12] Article cited in footnote 1, p. 557.

[13] Peary, Northward Over the "Great Ice," Vol. 1, p. 347.

other glacier that descended into a lake. A third glacier had no background of mountains. Looking eastward across the glaciers he now realized that he was standing above one of the great fiords on the east coast. The point is slightly northeast of Holger Kjaer's Nunatak. He now aimed for the land and in a few days reached Navy Cliff, and his conjecture of having been at one of the east coast fiords was confirmed. From Navy Cliff Peary observed a great depression to the northwest. He connected it with the depression parallel with the edge of the ice cap, which for several days had barred his way on the northeast. He had learned from experience how difficult it is to travel near the edge of the ice cap, and for this reason he remained on the level inland ice instead of attempting to follow the course of the depression. But, in the first place, he had a strong idea that all the glaciers stretching from latitude 82° N. to Navy Cliff ran northeastward and that the land between these glaciers was drained in the same direction; and, secondly, he saw a plateau to the north of the depression through which the glacier and the land were drained, a plateau whose rivers and valleys ran from the north towards the depression. Moreover, in a few places at the foot of the glaciers he saw level ice which he took for sea ice. His assumption of the existence of a channel was founded on the discovery of the great drainage system that separates Greenland proper from Peary Land.

Peary's only companion on the journey was the Norwegian Astrup, who related his experiences both in a lecture[14] and in a book.[15] The lecture was addressed to a wide public, and Navy Cliff and Independence Bay were only briefly mentioned, and the geographical results not further explained. Astrup's sketch maps do not correspond with Peary's maps; in particular as regards the northern border of the ice cap. In this connection it should, however, be noted that Peary's first maps of North Greenland differ greatly (compare, for instance, the map in "My Arctic Journal"). On Astrup's map there is no channel, a fact which provoked Charles Rabot's attack upon Peary.[16] This attack was answered from America.[17]

In 1900 Peary made a journey along the north coast of Greenland in the course of which he carried out a preliminary mapping of Lockwood's cairn and the northern and eastern part of the land which bears his name, but his discoveries on the journey had no bearing on the supposed channel. Some years later Peary's discoveries were entered upon official American[18] and Danish[19] maps.

[14] Eivind Astrup: Løitnant Peary's Grønlandsekspedition 1891–92, *Norske Geogr. Selskabs Årbog*, Vol. 4, 1892–93, pp. 25–44, with map of northern Greenland 1:6,000,000.

[15] Eivind Astrup: Blandt Nordpolens Naboer, Christiania, 1898; English translation by H. J. Bull: With Peary Near the Pole, London and Philadelphia, 1898.

[16] Charles Rabot: Les récentes explorations arctiques, *Compte Rendu des Séances de la Soc. de Géogr.* [*de Paris*], 1894, pp. 428–437; reference on p. 433.

[17] Mr. Peary's Work in Greenland, *Journ. Amer. Geogr. Soc.*, Vol. 27, 1895, pp. 60–62.

[18] Baffin Bay to Lincoln Sea, Polar Regions, showing the recent discoveries by Civil Engineer R. E. Peary, U. S. N., 1:1,400,000, *U. S. Hydrogr. Office Chart No. 2142*, 1903.

[19] Kort over Grønland, udgivet af Commissionen for Ledelsen af de geol. og geogr. Undersøgelser i Grønland, 1:2,000,000, Copenhagen, 1906.

In 1907 explorers again visited Independence Fjord. Mylius Erichsen and his two companions reached Cape Glacier and mapped Independence Fjord in its full extent. They spent the summer in Danmark Fjord, but in the autumn they succumbed to cold and starvation. The following year the body of Bronlund was found, together with a few sketches made by the cartographer Hoeg-Hagen. The head of Independence Fjord is not indicated on the sketch maps, but there is a panorama from the head of the fiord. On the sketch two glaciers are shown descending into the inner end of the fiord. However, in lack of further information on this part of the fiord, Peary Channel was retained on the maps issued by the Danmark Expedition.

The year after the return of the Danmark Expedition a new expedition started (1910) for the same regions, and in Danmark Fjord Captain Ejnar Mikkelsen found a brief report by Mylius Erichsen. This stated that he had reached Peary's Cape Glacier on June 1 and "discovered that the Peary Channel does *not* exist; Navy Cliff is connected by fast land with Heilprin Land."[20]

Ejnar Mikkelsen did not leave any copies of Mylius Erichsen's records in the cairns. His ship was frozen into the ice, and he was compelled to spend no less than three years in eastern Greenland; and thus news of his discoveries and of Mylius Erichsen's categorical denial of the existence of the Peary Channel was withheld until 1912.

Uneasy at Ejnar Mikkelsen's prolonged absence Knud Rasmussen, accompanied by the cartographer Peter Freuchen, started in the spring of 1912 from his trading station Thule in northwestern Greenland on an expedition across the inland ice to Danmark Fjord. In Danmark Fjord he found Mylius Erichsen's cairns without any reports and proceeded to Independence Fjord in ignorance of Erichsen's discoveries and Ejnar Mikkelsen's stay in Danmark Fjord. The summer was spent in musk-ox hunting north and west of Independence Fjord. The region, including ground covered by Peary and the site of the supposed channel, was mapped by Freuchen, and Peary's report from the cairn on Navy Cliff was brought home.

Rasmussen's journey, which was successfully accomplished and had been made almost exclusively with Eskimo equipment, caused a great sensation, both as an eminent feat of sportsmanship and because the new map seemed to settle some of the questions that once more came to the fore after Ejnar Mikkelsen had brought home Mylius Erichsen's reports.[21] Immediately on his return Knud Rasmussen published a very brief report of the journey[22] and some time later a more extensive report.[23] In both these latter reports

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[20] G. C. Amdrup: Mylius-Erichsen's Report on the Non-Existence of the Peary Channel; Information Brought Home by Ejnar Mikkelsen, *Meddelelser om Grønland*, Vol. 41, 1913, pp. 469–474; reference on p. 472, and "Alabama-Expeditionen til Grønlands nordøstkyst 1909–1912, Report on the Expedition by Ejnar Mikkelsen," *ibid.*, Vol. 52, 1922, pp. 1-142; reference on p. 90.

[21] An exceedingly clear and perspicuous account of the journeys is given by Captain Daniel Bruun: Peary Land landfast med Grønland, *Geogr. Tidskrift*, Vol. 22, 1913–14, pp. 85–92.

[22] *Loc. cit.*, p. 41.

[23] Knud Rasmussen: Foreløbig om "Den første Thule-Ekspedition" 1912–13, *ibid.*, pp. 183-198; *idem:* Den første Thule-Ekspedition frem og tilbage over Indlandsisen, *Ymer*, 1915, pp. 133-163.

the map is published without any attempt to explain the disagreements between Peary's original sketch and the new map.

In 1915 the final "Report of the First Thule Expedition 1912," by Knud Rasmussen and Peter Freuchen, was published in *Meddelelser om Grønland*.[24] In the text Freuchen made some reservations with regard to the correctness[25] of his map though he might have gone further and pointed out its essentially reconnaissance nature. A comparison of Figures 2 and 3 reveals the errors in Freuchen's map. This is not surprising. The work was carried out under difficulties: he was suffering to some extent from snow blindness, the instruments were not in good condition, and several long spells of bad weather were encountered.

The situation as it then stood was reviewed in the *Geographical Review* in June, 1916,[26] Freuchen's map being accepted and an attempt being made to explain Peary's conclusions. In the same year J. P. Koch's "Survey of Northeast Greenland" was published.[27] In this work Koch discussed Freuchen's map of the head of Independence Fjord[28] and tried to make it correspond with the very few observations we have left from Hagen's journey, more especially a perspective sketch from the head of Independence Fjord.

When in 1921 I traveled from the east into Independence Fjord, I carried with me the whole literature concerning the Peary Channel question. I had reached the conclusion, from what Peary had written on this subject, that there must exist a deep depression seen by him but by no one subsequently. My search for such a depression proved less difficult than I had dared to hope. When on June 7 in about longitude 28° W. I got a wide view into Brønlund Fjord, it at once struck me that the continuation of this fiord was not, as shown on Freuchen's map, a great ice cap, but that a valley or perhaps even a fiord extended far westward. The valley was so wide that I hoped by traveling through it to reach the inland ice; and for this purpose I traveled to the head of Independence Fjord, accompanied by one of my Eskimos, and thence to Brønlund Fjord. Meantime my two other Eskimos had gone there on a hunting expedition, and they told me that Brønlund Fjord was of short extent, whereas even from a rather considerable height they could not see the end of the valley. As it contained little snow, however, travel through it was impossible. Successful musk-ox hunting along the coast supplied us with sufficient provisions to enable us to map about 100 kilometers of this valley, in the interior of which there was a large low-lying lake. Later in the summer, in the middle of July, I had the opportunity of following Peary's traveling route on the ice cap to about latitude 82° N., and from this place I once more looked down on the lake. Thus I had found the large drainage territory that Peary saw, and in

[24] *Meddelelser om Grønland*, Vol. 51, 1915, pp. 283–425.
[25] *Loc. cit.*, pp. 415–418.
[26] The Non-Existence of Peary Channel, *Geogr. Rev.*, Vol. 1, 1916, pp. 448–452.
[27] *Meddelelser om Grønland*, Vol. 46, 1916, pp. 79–468.
[28] *Op. cit.*, pp. 379–392.

my opinion he was perfectly justified in taking it for a channel. This drainage area had not been observed by Knud Rasmussen and Freuchen. My discoveries in these regions I have briefly mentioned in previous articles.[29]

When now, on the basis of my map, we recapitulate the history of Peary Channel we see that the sketch Peary brought home was substantially correct with regard to almost all points in the environs of Navy Cliff, Peary's only real cartographical station during his journey; and further we see that Peary marked the drainage area as a channel. On my map we find Peary's four glaciers. Two of these descend into very low-lying lakes, the third is drained northward through Brønlund Fjord like the two first mentioned, and the fourth, first discovered by Mylius Erichsen and by him called Marie Sophie Glacier, debouches into the head of Independence Fjord. Light on the way in which Peary's mistakes arose is gained by noting that he drew the coast east of Cape Glacier in a southeastward direction. From Navy Cliff he saw what he called Academy Land. On his map we find the two small local ice caps that exist here; but, as Peary stood only at a height of 890 meters, and the mountains surrounding Cape Glacier were at least 100 meters higher, and the top of the northern ice cap another 100 meters higher, he naturally got the impression that the coast turned southeastward behind the northern ice cap, where a great valley extends in that direction. This idea was confirmed when from Navy Cliff he looked southeastward across a plateau with local ice caps and in several places far away saw land, probably situated behind Hagen's Fjord and around the head of Independence Fjord.

In conclusion I would emphasize the high quality of Peary's sketch map, and the justification for his assumption of the insularity of the land he discovered—land which now properly bears his name. Morphologically it may be regarded as an island, though it is not separated from Greenland by a channel but by a broad low depression that perhaps once after the glacial period, when the land was less high, was actually submerged.

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[29] Lauge Koch: Preliminary Report on the Results of the Danish Bicentenary Expedition to North Greenland, *Geogr. Journ.*, Vol. 62, 1923, pp. 103–117, and *idem:* North of Greenland, *ibid.*, Vol. 64, 1924, pp. 6–21.

THE FIRST SIGHTING OF WEST ANTARCTICA

By Edwin Swift Balch

The Voyage of Bransfield

In the *Geographical Journal* for March, 1925 (pp. 220–225), there is an exceedingly interesting article by Lieutenant Commander R. T. Gould, R. N., "The First Sighting of the Antarctic Continent." This article is based on an account of the voyage of Edward Bransfield published in the *Literary Gazette* of November 3, 10, and 24, 1821, and which was traced a few years ago by Dr. W. S. Bruce. This is evidently much more detailed and accurate than the account published in 1821 in the *Edinburgh Philosophical Journal* which Commander Gould truly says is "of a very vague character." One of the curiosities of this article is the signature "H. M. S. Slaney." At least three writers, Dr. Fricker, Dr. Mill, and myself, in turn took it for the name of the author. Later I traced a French translation of the article and found that the author was Dr. Young of "His Majesty's Ship *Slaney*."

In the recently unearthed article in the *Literary Gazette* it is stated that from a point in latitude 63° 16′ S., longitude 60° 28′ W., at 3 P. M. on January 30, 1820, land was sighted to the "S.W." As shown on Commander Gould's map, from that point and also from the point immediately beyond where Bransfield turned east at 4 P. M. land to the southwest and trending to the eastward was in the exact position of and must have been what is now known as Trinity Island. Had Bransfield sighted the mainland, he would have said land to the south, for the mainland was south and not southwest.

Farther eastward, however, at the extreme eastern end of the peninsula, Bransfield sighted the high mountain now known as Mt. Bransfield. Apparently this was the only point on the mainland he certainly did sight. But in so doing he seems almost surely to have had the first glimpse of the mainland of West Antarctica.

In itself the voyage of Bransfield was of less importance than the voyage of William Smith, which Dr. Otto Nordenskiöld was the first to recognize as the real start of sealing and exploration in the western Antarctic. Nordenskiöld also urged seeking further information about Bransfield; and since such information has now been found, it would be a boon to all students of Antarctic discovery if the *Geographical Journal* would republish in full and verbatim the account in the *Literary Gazette*.

It is unfortunately necessary, however, to speak critically of the map accompanying the article in the *Geographical Journal*. For on this the name "Trinity Land" is marked in big letters across the northern part of the mainland.

There are no native names in the Antarctic. As a result of this, all the names in use there are those given either by explorers or by stay-at-home geographers interested in the matter. And the names adopted show clearly that the consensus of opinion is that, as far as possible, all names in the Antarctic should memorialize the discoverers, their discoveries, and their nationalities. Now the gradual unfolding and placing on the map of the lands and waters beyond latitude 60° S. are due to the explorers and

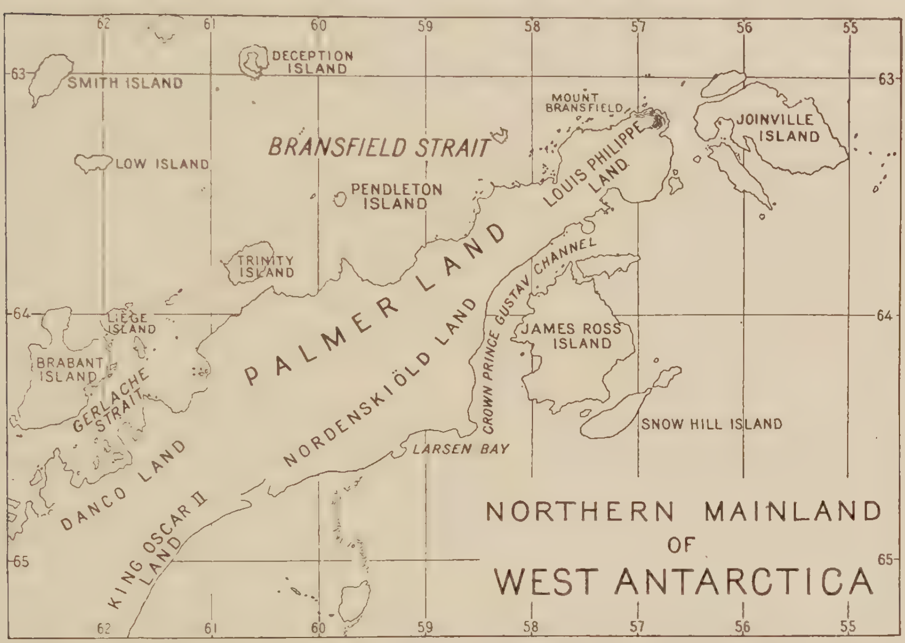

FIG. 1—Sketch map of the northern mainland of West Antarctica showing Palmer Land and Mount Bransfield.

mariners of many nations. Consequently, justice and good sportsmanship demand that credit should be given not merely to two or three explorers and nationalities but to all the explorers and nationalities that have contributed in revealing the configuration of the South Polar regions.

Palmer Land on the Map

Bransfield himself has the great memorial of "Bransfield Strait" and the lesser one of "Mt. Bransfield." The name "Trinity Land" has remained as "Trinity Island," and this is a sufficient memorial of the Trinity Board. Although Commander Gould admits there might be a difference of opinion about Bransfield's sighting the mainland, he says unqualifiedly that "part at least of Palmer Land had been previously discovered (and named 'Trinity Land')" by Bransfield. This may be true, but it may equally well not be true. For it is certainly extremely doubtful whether

Bransfield sighted any part of the mainland except Mt. Bransfield at the tip of the eastern end, which is generally known as "Louis Philippe Land."

"Palmer's Land" first appears on Laurie's Chart of November 1, 1822, as the name of the northern coast of the mainland from about longitude 57° W. to the entrance of Gerlache Strait and the northern tip of Liège Island in about longitude 62° W. This name, after many vicissitudes partly due to imperfect knowledge, has finally remained attached to it. And it is right that it should!

For "Palmer Land" memorializes the name of Nathaniel Brown Palmer, who may have been the first to sight the western part of the northern coast and who certainly was the first to recognize that it was a large mass of unbroken land. The name also memorializes the Stonington sealers and explorers, whose cruises revealed many of the secrets of the western Antarctic. To take the name away would be tantamount to destroying all memories of American discovery in West Antarctica. Justice therefore requires that the northern coast from Gerlache Strait to longitude 58° W. should continue to bear the name "Palmer Land."

The Possibility of Earlier Discovery

The tracing after so many years of the doings of Bransfield raises hopes that other forgotten data may yet come to light. Historical geographers should remember that in Herrera's "Description des Indes Occidentales," published in 1622 in French, Latin, and Dutch, there is an account of an Antarctic land which, in both position and described aspect, tallies with West Antarctica. A translation of part of the French account reads as follows: "The ship of Dirck Gerritsz, which had parted company on the 15th of September with the others, namely Wert and Cordes, was carried by the tempest down to 64° south of the Strait: where they discovered a high land with mountains covered with snow, resembling the land of Norway."

This account is too circumstantial and too accurately descriptive to be based on mere imagination. In certain respects it is analogous to Juan de la Cosa's map, which is perhaps the one positive proof of the rediscovery of North America by John Cabot. Like Juan de la Cosa's map, Herrera's account seems to record a fact, and it was so accepted at the beginning of the nineteenth century. It has since fallen rather into disrepute, however, partly because in 1899 Dr. Arthur Wichmann published two documents found by him in the Royal Archives at The Hague, documents which I examined later and whereof I had copies made. One of these documents states that Dirck Gerritsz went to latitude 56° S. and therefore could not have seen West Antarctica. The other document, which does not mention an Antarctic land, tells however of a ship under Don Gabriel de Castiglio, which in 1603 did reach latitude 64° S. where they had a great deal of snow.

Granting now that Dirck Gerritsz was mistakenly assumed to be the discoverer of land in 64° south of Cape Horn, yet, when we consider that one ship is recorded as having reached latitude 64° S. in 1603 and that in 1622 there was published an account of a land in latitude 64° S. answering in all respects to West Antarctica, it is almost certain that some one sighted it over three hundred years ago. I wrote to this effect in 1902 in "Antarctica." The finding of the Bransfield records renews my hopes that still buried records may some day be found, perhaps in Spanish archives, about this forgotten seventeenth century mariner. But whether his name is ever traced or not, it is my firm belief that before the year 1622 some one sighted at least one of the islands of the land mass of West Antarctica.

GEOGRAPHICAL RECORD

NORTH AMERICA

The Discovery of Aniakchak Crater, Alaska. In 1922, while engaged in reconnaissance survey on the Alaska Peninsula west of the Aleutian Range, R. H. Sargent and Walter R. Smith of the U. S. Geological Survey discovered a gigantic crater which they named Aniakchak from the river taking its source therein. The crater lies just west of the 158th meridian and south of the 57th parallel. It is about a hundred and fifty miles southwest of Katmai, which it appears to resemble in origin but far surpasses in size. In shape and magnitude it compares with Crater Lake. The circumference is 19 miles, the minimum diameter a little less than 6 miles, the maximum diameter 6¾ miles (the maximum diameter of Katmai is 3 miles). From the lowest point on the floor, 1000 feet altitude, to the highest crest of the rim the difference of elevation is 3200 feet. The average height of the crater walls is 1600 feet, although in places they reach 2000 feet. A black truncated cinder cone rises 2200 feet above the floor of the crater, and there are several mud cones from 200 to 300 feet in height. A beautiful lake 2½ miles long, named Surprise Lake, occupies the extreme northeastern portion of the amphitheater. From it the Aniakchak River, here a stream 75 feet wide and 3 feet deep, plunges down a rather steep bed and breaks through the southeastern portion of the rim in a picturesque gorge, the "Gates."

The valleys of the surrounding country for many miles are covered by thick deposits of ejecta from the crater, fine ash, fragments of black and pink lava, and gray, black, and red pumice. Vegetation has gained a footing in places, but large areas within a radius of twenty miles from the crater are entirely barren of plant life and have the appearance of arid plains.

All the evidence available indicates that this great crater was formed by explosion and not by subsidence, as is considered the explanation of all known craters of similar size, Crater Lake for instance. Sufficient data on which to base an estimate of the date of eruption were not collected, but the consolidated material in some of the valleys and the amount of stream erosion suggest that it is one of the oldest of the series of volcanoes along the Aleutian Range and that the eruption antedates historic record.

Mr. Smith's account of the crater, published as *U. S. Geological Survey Professional Paper 132 J*, 1925, includes a relief map of the crater and vicinity and a striking panorama looking across the cinder cone and lake.

Materials for the Geographical Study of American Ports. A collection of documents dealing with the ports of the United States is now being published by the Corps of Engineers of the U. S. Army and the U. S. Shipping Board. The material in this "Port Series" will provide American students with a starting point for studies of the geography of ports comparable to the excellent investigations in this field being carried on by the French (see Albert Demangeon: The Port of Paris, *Geogr. Rev.*, Vol. 10, 1920, pp. 277–296). Each volume contains, in the first place, a variety of data covering local conditions, such as topography, tides, weather, health, bridges, terminal facilities, customs regulations, pilotage, wharfage, lighterage, labor, fuel, supplies, communications, etc. This is followed by discussions and statistics regarding the commerce of the port and the various factors that affect this commerce, both natural (such as relative distances) and artificial (such as railway freight rates). The volumes are illustrated with airplane views, photo-

graphs, maps, and cartograms showing the ports themselves, the interior territories served by them, and the extent of their commerce. Five volumes have been published to date: No. 1, Portland, Me., 1921; No. 2, Boston, Mass., 1922; No. 3, Mobile, Ala., and Pensacola, Fla., 1922; No. 4, Philadelphia, Pa. (including Camden, N. J., Chester, Pa., and Wilmington, Del.), 1922; No. 5, New Orleans, La., 1924.

Geographical conditions adverse to the development of a port may often be neutralized by the handiwork of man, either by physical improvements of the harbor and its facilities or by the granting of freight differentials and similar transportation privileges. Unfortunately the reverse is also sometimes possible—the erection of artificial obstacles in the way of the growth of a port otherwise favored geographically.

A striking example of natural disadvantages in a port is offered at New Orleans. The sliding of the banks along the Mississippi has "caused practically all of the longitudinal wharf structures to push outward more or less, and wharves have actually given way completely, practically without warning. The existing development consists primarily of a succession of covered wharves paralleling the river bank." Owing to the treacherous foundations upon which these wharves are built, it has been necessary to place the railway tracks "entirely in the rear of the sheds, thus necessitating the unloading of practically all railroad freight at the rear of the sheds, and its transportation by longshoremen across the entire width of the wharves to ship side." This has resulted in the loss of "many shipments [especially of heavy commodities such as machinery] which might otherwise have been routed advantageously through the port." The construction of slips communicating with the canal recently built between the Mississippi and Lake Pontchartrain and of ship-side warehouses along its banks ought ultimately to do away with this difficulty.

A case where artificial factors have neutralized natural advantages is provided at Portland, Me. While Portland serves primarily as a winter outlet for Canadian grain, its fine harbor and central position would seem to make it the logical port of northern New England. It does not, however, enjoy this status. "The failure of Portland to attract trade from and to the territory which might be considered geographically tributary to it is due to a number of causes, but the most important cause is the lack of facilities for handling such traffic," facilities which the railroads seem unwilling to provide. "While the interests of the shipper in many cases would be best served by the utilization of the shortest rail haul, the interests of the railroads are often better served by compelling traffic to find its outlet through a port involving a longer haul." This explains largely why "the principal movement of export traffic from New England is through [neither Boston nor Portland but through] the port of New York."

The Temperature of Ground and Surface Waters in the United States. The temperature of ground and surface waters is a fact of importance in relation to the industrial use of these waters. The matter is discussed by W. D. Collins in *U. S. Geol. Survey Water-Supply Paper 520–F*, Washington, 1925.

The temperature of non-thermal ground water below a depth of 30 feet is, broadly speaking, unvariable, being practically uninfluenced by atmospheric seasonal changes. From 20 to 200 feet below the surface this temperature usually stands from 3° to 6° F. higher than the mean annual temperature of the atmosphere. Therefore, on the basis of the isothermal maps showing the latter, it is possible to construct fairly accurate maps of the approximate ground water temperatures. Such a map for the United States accompanies Mr. Collins' paper.

The temperature of the surface water in lakes and rivers, on the other hand, varies with the seasons, corresponding in a general way to the monthly mean temperature of the air. During the spring and early summer the water temperature is usually a

few degrees cooler than that of the air. "On the average the water temperature will be within 3° above or below the mean monthly air temperature in July and from 2° to 5° above the mean in August." During the autumn months the water cools throughout most of the United States until it reaches the minimum of 32° to 34°; it does not, however, cool as rapidly as the air, maintaining an average temperature a few degrees higher than that of the monthly mean atmospheric temperature.

Several interesting exceptions to the generally applicable rule are noted. "Mountain streams, which may be formed largely from melting snow and may flow quickly into plains where the temperature is high, will have a temperature much below the mean monthly air temperature in the plains." The Mississippi River, coming in winter and spring from a colder region to the north, maintains a temperature much colder normally than the atmosphere at New Orleans. During July, August, and September, on the other hand, when the Mississippi valley experiences almost as warm weather throughout its entire extent as that which prevails at New Orleans, the river water at New Orleans is as warm as and warmer than the air. At Youngstown, Ohio, we have the anomalous condition of river water throughout the year maintaining a considerably higher temperature than that of the air. This "results from the use of the water for cooling at industrial plants above Youngstown," a process which raises the temperature some 20° in summer.

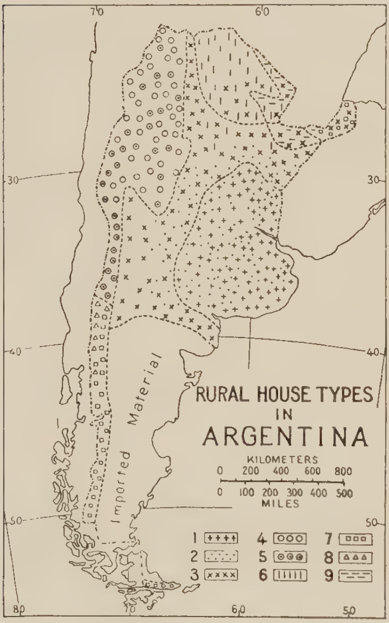

FIG. 1—Distribution of rural house types in Argentina. From the map accompanying Dr. Kühn's paper. 1, walls of brick; 2, of mud; 3, of branches; 4, of adobe; 5, of stone (*pirca*); 6, of wooden stakes; 7, of wooden boards; 8, Araucanian houses; 9, roof of palm shingles.

SOUTH AMERICA

Rural Habitations in Argentina. "Ecogeografía" has received little attention in Argentina. Ecogeografía is Dr. Francisco Kühn's equivalent of the German "Siedelungskunde," what the French call the study of "établissements humaines," for which no precise term seems to exist in English. The possibilities for such study in Argentina are indicated by Dr. Kühn in a paper entitled "Material de observación para la ecogeografía argentina: Algunos tipos de viviendas rurales" (*Univ. Nacl. de Buenos Aires, Publ. del Inst. de Investigaciones Geogr. No. 8*, 1924).

In his introduction Dr. Kühn makes the prime distinction into nomad and sedentary habitations. Today the former, at least that of primitive type, is to be met with only in the extreme north and south of the country, in the Chaco and Fuegia. A modern form, however, may be said to obtain on the pampas where the agricultural colonist occupying land on a short-term contract too often lives in a wretched temporary hovel. The sedentary habitation is a good index to the state of civilization of a country. The rural dwellings of Argentina in general are characterized by uniformity, primitiveness, and lack of both adornment and convenience. The climate plays its part: commonly the habitation merely provides shelter for eating and sleeping in a life passed essentially in the open.

Dr. Kühn discusses in some detail the habitations of two regions, the arid mountains of the northwest and the wooded zone of the Patagonian cordillera. In the former are two main types in sympathy with two valley types. The structural valleys, *bolsóns*, with an alluvial fill supply material for the walls of the adobe house. The framework is often of algarrobo wood. The roof of single or double pitch and sometimes projected to form a veranda is covered with cane or reeds. The houses of the *estancias* are of the same type as the isolated farm huts but of superior construction, and very similar houses are found in the small isolated towns. Dr. Kühn notes an interesting exception in the Diamante valley of Mendoza. Where the river flows in a deep-sunk bed across the semidesert of the Pampa de Diamante the houses are built entirely of boulders from the stream with a fine argillaceous sand used as mortar.

In the lateral *quebradas* stone is the only material available for the house walls. Here we have the *pirca*, a pre-Hispanic type, of undressed stone laid without mortar. The roof is turf covered on a frame of cactus, the only local building wood, though in some districts not far from the borders of the subtropical forest bamboo is procured. The *pirca* varies considerably in merit. The inferior forms, often very low structures, are found in the remotest spots. In the superior the single structure has been differentiated into dwelling, kitchen, and storehouse enclosing a patio. Furniture, however, is still lacking; the occupants sleep on the ground.

On the arid Patagonian plains all building material is imported. Westward, however, we come to the wooded zone of the cordillera. Here the houses of the colonists and *estancieros* are of local timber in European style. The huts of the aboriginals are on traditional lines. Three main forms may be distinguished according as the huts are built entirely of bamboo, of logs with bamboo roof, or of solid timber roof. The last is found in the very scantily populated zone of thick wet woods of the Chilean type where excellent material is available and the climate calls for substantial structures.

Chilean Port Development. Until recently the west coast ports of South America have been of two classes—open roadsteads and unimproved natural harbors. In the case of the former shipping was so completely unprotected from wind and current that, except at times of comparative calm, unloading of both passengers and freight was difficult and often dangerous. In the case of the latter shipping was protected from winds from certain directions but was not only completely exposed to winds from other directions but was in even greater danger than at the open roadsteads because of the various effects of the configuration of the harbor on the direction and force of waves and currents. At Valparaiso, for instance, where the bay protects shipping on the south and east, the harbor opens to the north and northwest and the Commission of Ports of Chile has found that in building a breakwater to protect the harbor from storms from these directions protection must be provided against storm waves that rise to six, eight, and in exceptional cases, twelve meters in height. In both the roadsteads and the natural harbors ships have to anchor at some distance from the shore, and freight must be transferred to the shore by means of lighters—a laborious and costly system even in good weather.

Throughout the west coast countries the extensive exploitation of mineral resources made possible by the Panama Canal and the consequent increase in the demand for American and European manufactures have so increased the shipping at certain ports that the necessity of improving facilities for speedy loading and unloading of ships is everywhere seen as a vital problem. This is particularly the case in Chile, not only on account of local development of mineral and agricultural resources but also because of the international railways in actual operation or projected with termini in Chilean ports. The Chilean government has responded with a program of port development which is being rapidly carried out (see Eduardo

Reyes Cox: The Ports of Chile: Works of Improvement, *Bull. Pan-Amer. Union*, Washington, Vol. 59, 1925, pp. 115–133).

In order of importance as established by the Commission of Ports created by Federal law in 1910, the following ports have been declared as in most immediate need of development: Valparaiso, Antofagasta, Arica, Talcahuano, Lebu, and Valdivia. At Valparaiso the development work begun in 1912 is now almost completed except for one section of the breakwater for which the contract has recently been let. The development includes 1000 meters of breakwater, over 2500 meters of dock space, and loading and unloading equipment of the most modern type. At San Antonio, the port auxiliary to Valparaiso, the improvement work is finished. At Antofagasta, Pacific coast terminus of the Antofagasta and Bolivia railway and shipping port for the copper region of northern Chile as well as for a large section of the nitrate region, work is well under way. At Valdivia, which will be the Pacific coast terminus of the proposed railroad to San Antonio, Argentina, the construction of embankments on the Valdivia River and stone dikes to prevent the formation of sand bars has been completed. At Constitución, port of an important agricultural district, dikes on the Maule River and an anteport protected by jetties and connected by canal with an inner port on the river are under construction. At Lebu, port of the coal region of south-central Chile and now being connected with Los Sauces by a railway which it is planned to extend to meet the Argentine railway under construction from Bahía Blanca to Lonquimai, improvement work is planned similar to that at Constitución. Bids are now being called for for the construction of jetties and docks at Arica, Pacific coast terminus of the Arica-La Paz railway.

Similar projects are being considered in the other west coast countries. At Buenaventura, which, with the completion of the Pacific railway from Ibagué, will rise to the position of a major Pacific port, one concrete wharf has been built, and the dredging of the harbor and the diking of the mouth of the Dagua River are planned. The plans for the Quito-Esmeraldas railway provide for harbor improvements at San Lorenzo. The project for a railway from Quito to Bahía de Caraques includes plans for breakwaters and docks.

EUROPE

The Place Names of France. À propos of the posthumous publication now in progress of Auguste Longnon's monumental work, "Les noms de lieu de la France," Albert Dauzat contributes a short but informative article to *La Nature* for May 9, 1925, pp. 289–293. He shows that the study of European place names cannot be attempted by anyone without a thorough grounding in linguistics. On the other hand an historical and geographical background for researches in this field is of almost equal importance: "Longnon luimême ne vint à la linguistique qu'à travers la géographie et l'histoire."

The place names of France were established essentially in their present form by the thirteenth century. They seem to have been derived from four principal sources: (1) the pre-Celtic inhabitants of France; (2) the Celts; (3) the Romans, and (4) the Teutonic invaders. The names of the more important rivers, Seine, Loire, Garonne, Rhône, Allier, and Meuse, are all of pre-Celtic origin. Some of the pre-Celtic names, particularly in the Alpine region, may have come from the Ligurian, an obscure Indo-European tongue about which little is known. Celtic and Latin names are widely distributed, the latter being particularly numerous in the south; the Teutonic element is especially well represented in Normandy.

Most European place names were first derived either from natural features or from works of man, or else were given in honor of some individual. The religious life of the Middle Ages produced a quantity of variants of the Latin *basilica* (church)

and *monasterium* (monastery), such as: Bazauges, Basouges, Bazoches, Moutiers, Montier, Monestier, Montrieul, Montereau, Monistrol, etc., and many localities are named after saints. The laws governing the transformation of names vary with local dialects; thus the Latin *fabrica* becomes Fabrègue in Provence, Fargue in the southwest, Farge in Auvergne and Limousin, Faverge in Savoy, Forge in *langue d'oïl.* Many names are transformed through false analogies and popular etymologies and not infrequently through copyists' errors on charters and other documents and on maps.

If correctly understood and properly interpreted, place names may give a clue to historical geography. They sometimes show the areas formerly occupied but subsequently abandoned by a tribe or people. The evidence from place names, for instance, indicates that the Norse colonization of Normandy was less dense in the south than in the north, an inference confirmed by historical records and by the distribution of types of rural habitation. Occasionally toponymy may even furnish the sole clue to prehistoric racial habitats.

AFRICA

Dakar, An Imperial City. A sandy beach, silent, deserted; native huts and some few European business houses, ill-defined streets, choked with sand; the rocky islet of Gorée with its dismantled fort and ruined houses; bare red crests of the "monts du Cap Verd"; to eastward a stretch of dull gray coast relieved only by an occasional palm; laterite and aridity the dominant features of the landscape. This is Camille Guy's picture of Dakar at the beginning of the century when the settlement numbered half a hundred whites and two to three thousand natives and steamers called at the port twice a month (Dakar ville impériale, *L'Afrique Française*, Vol. 34, 1924, pp. 580–586). Today Dakar has 3000 Europeans and 27,000 natives; the improved port cannot accommodate the number of large vessels that call, and further works are under consideration.

This progress is not surprising. Dakar occupies a strategic situation, the most westerly point of Africa, the point nearest South America; it is a port of call for ships sailing along the west African coast and from Europe to South America, and now enters into successful competition with the ports of the Canaries. Furthermore, Dakar lies on the northern boundary of the Sudan and thus is a mercantile port for a great and growing hinterland. At present two railway lines serve the port—from St. Louis and from Kayes, the latter 1200 kilometers long. Dakar already is known for its important wireless station and has before it a future as an aviation station. The establishment of aerial lines between France and French West Africa and South America is again being discussed in France. Doubtless the final achievement is remote, but Henry Hubert gives some practical plans for the portion of the route between Port Étienne, the most northerly point of French West Africa, and Dakar, 700 kilometers in air line (La sécurité de la navigation aérienne entre Port-Étienne et Dakar, *Bull. Comité d'Études Hist. et Sci. de l'Afrique Occidentale Française*, Vol. 8, 1925, pp. 9–56).

The chief handicaps to the growth of Dakar have lain in the lack of water and local resources. The town is now supplied with water from some distance by conduit, and another conduit is under construction. Wells have been sunk and water vegetable gardens whose product is sufficient not only to provision the inhabitants but to supply passing ships. An oil depot to hold 20,000 tons is being added to the coal depot.

The latest event in the history of the town is the clearing up of a somewhat anomalous political situation. Dakar is capital of the eight colonies that compose French West Africa, but it was situated in Senegal which has its own capital in

St. Louis. By decree of October, 1924, the communes of Dakar and Gorée with an adjacent area containing the springs that aliment the town is created an autonomous territory. Thus, says M. Guy, Dakar becomes truly an imperial city, *urbs*, in the Latin sense of the word.

An Aerial Survey of Dakar. In the *Bulletin du Comité d'Études Historiques et Scientifiques de l'Afrique Occidentale Francaise* (No. 1, 1923) there is an interesting and lucid account of how the recently published map (1:10,000) of the Dakar peninsula was made. This account is particularly noteworthy as new methods were employed and as the results, excellently reproduced, seem to be cartographically all that could be desired.

Three previous triangulations of the area were used in conjunction together to form the major control. The whole area, about 32 square miles, was then photographed from the air in flights totaling only 6 hours in duration. The overlap of photographs was, however, very uneven and less than 30 per cent. A plane table triangulation was also made in order that sufficient control points might be available on each photograph. The method of transferring the required topographical detail onto "la feuille de projection" consisted first of all in the identification and accentuation on the photographs of the details required. These were determined by a stereoscopic examination or, in the case of town areas and where there was much topographical detail, by examination of photographs taken at a lower altitude. These accentuated photographs were then rephotographed by a method very similar to M. Roussilhe's now well-known method of "photo-restitution" so that all appreciable distortion due to tilt and inequalities of scale was eliminated. The survey was fortunate in not having to contend, except in one instance, with differences of altitude exceeding 40 meters. The now undistorted topography was then transferred direct to the working copy of the map.

The result was "une carte muette," which phrase aptly calls attention to a point which is often forgotten in extolling the merits of aerial surveying. Consequently, a further reconnaissance was made in order to supply place names, etc.

Owing to the fact that natural objects easily identifiable were, for the most part, chosen as control points and that the survey was able to use previously executed triangulation, the whole work was accomplished with speed and economy. In respect to time, experience showed that an aerial survey shortens the field work to such an extent that it more than counterbalances the increased time taken in drawing the map in the office.

It is worthy of note that no difficulty was experienced in flying at a sufficiently constant altitude and that distortion errors were nearly all due to tilt. This tilt of the camera was almost a constant, varying very little from one consecutive photograph to the next.

ASIA

The Glaciers of Turkestan. In articles published since the Revolution, Russian geographers present a considerable amount of new information concerning the glaciers of this still little-known region, to which American and Western European authorities have lately also given a great deal of attention. The most important of recent explorations by foreign scholars was the Pamir-Alai expedition of the German and Austrian Alpine Society in 1913, reported by W. Rickmer Rickmers and R. von Klebelsberg in the Society's *Zeitschrift* for 1914 (Vol. 45, pp. 1–60) and by Rickmers in the *Geographical Journal* for December, 1913 (Vol. 42, p. 570), and February, 1914 (Vol. 43, pp. 182–184). An expedition in 1914 of Fritz Machatschek, one of the foremost authorities on the region, was not primarily for the study of its glaciers

(see accounts by him in *Zeitschr. Gesell. für Erdkunde zu Berlin*, 1915, pp. 155–170, and *Mitt. K. K. Geogr. Gesell. in Wien*, Vol. 58, 1915, pp. 350–399).

The further observations of Russian scholars accord with previous studies in the conclusion that the glaciation of Turkestan is predominantly of the "valley (or Himalayan) type" in its strictest sense, the elongated main *névé* being fed by tributary ice streams. The large glaciers still in existence are of this type, and the smaller ones are derivative forms left by the disappearance of such glaciers existing in the past—cirque glaciers, hanging glaciers, etc. A number of examples of all these forms are described by D. I. Mushketov in the *Izvestia* of the Russian Geographical Society for 1917 (Vol. 53, pp. 83–136) in an article covering his studies during the preceding six years of the glaciers of eastern Ferghana and the Alai valley. V. A. Nikolaev, who describes the glaciation of the Dzungarian Ala-tau in the *Izvestia* of the Geographical Institute for 1923 (Part IV, pp. 32–38), found there only residual cirque and hanging glaciers on the slopes with northward exposures. In the western Kunlun Mountains, the glaciation of which is described by G. Sobolevski in the Geographical Society's *Izvestia* for 1918 (Vol. 54, pp. 27–56), practically no active vestiges of true valley glaciation remain. These mountains were long supposed to be entirely without present glacial activity; but on the northern slopes above a series of abandoned cirques are found small, irregular hanging glaciers without proper *névés*, descending directly from the lofty snow line. They terminate at much higher altitudes than the glaciers of other parts of Turkestan—an average of 4370 meters, as compared with about 3500 meters in the Alai and the Ala-tau. These characteristics are attributed by Sobolevski to the scarcity of moisture in the district, isolated by higher ranges, and to the uncommon steepness of the slopes.

One of the greatest glaciers of Turkestan, the Garmo in the Darvaz highland of eastern Bukhara, hitherto unexplored except for a passing visit of the Rickmers party, is described by I. I. Beliaev and P. I. Besedin in the 1923 number of the same publication (Vol. 55, pp. 1–123). Although both explorers had other aims in view and confess to a lack of competence in glaciology, they present a sufficiently striking picture of a magnificent ramified valley glacier. The Garmo forms one of a knot of mighty glaciers radiating south of the Peter the Great Range into the valleys of the Khingou and Vanch Rivers and north of it into the valley of the Muk-su. Their upper limits remain inadequately explored, but stories current among the native Tadziks of passages made from one to another give ground for conjectures as to the existence of practicable cols across the main divide. Beliaev, however, failed to find any such passage from the Garmo glacier, which lies on the southern slope. He was likewise unable to get any definite information about a pass at the head of the neighboring Kashal-aiak glacier, in the Vanch valley, which he had not enough resources remaining to explore. N. L. Korzhenevski, who, in the *Izvestia* of the Geographical Society's Turkestan Section for 1922 (Vol. 15, pp. 23–27), describes the Fedchenko (Sel-dara) and Mushketov (Kara-sel) glaciers of the Muk-su valley, supposes an actual coalescence of the *névé* of the former with that of the Kashal-aiak across the divide. The Fedchenko glacier, characterized by this writer as approaching the "expanded foot" type, is also described in Mushketov's article as debouching peculiarly, a mass of clear ice without terminal moraine, directly into an alluvial valley.

Korzhenevski's observations, made in 1914, of the two glaciers with which he deals showed notable changes from conditions recorded by him in 1904 and 1910. In both cases the ice had greatly increased in volume, filling up and pushing forward into the valleys. An earlier observer's record is cited of a similar advance noted in 1878, indicating a correspondence with the contemporary behavior of Alpine glaciers. In contrast to this glacial advance in Turkestan, however, is to be noted a report by P. Tsirulnikov in the parent Society's *Izvestia* for 1917 (Vol. 53, pp. 45–55) of obser-

vations of several glaciers in the Caucasus, showing a consistent recession, averaging several rods a year, over a period of years preceding 1914 and 1915.

On all the mountain slopes of Turkestan are found traces of earlier glaciation on a far grander scale than the present, though still of the isolated valley type, indicating no extensive ice sheet. Mushketov presents comparative measurements of the altitudes of existing termini and older terminal moraines in the cases of thirty-seven glaciers in the districts with which he deals. While the absolute figures vary considerably, the ratios are fairly constant, showing an average difference of altitude between present and lowermost former termini of about 1000 meters. In about half the cases, moreover, measurements are given for a distinct intermediate moraine; while, in some, observations are recorded of still others. The general conclusions emerging from these data are thus in accord with those reached by Ellsworth Huntington in his "A Geologic and Physiographic Reconnaissance in Central Turkestan," published among the accounts of the Pumpelly expedition of 1903 by the Carnegie Institution (Washington, 1905): namely, that they show the former existence of at least two major glacial epochs, separated by warmer periods. While Huntington believes he has some ground for increasing the number to five, Mushketov contents himself with the supposition of two phases of advance in the second epoch. Nikolaev's observations in the Ala-tau yield similar results, as do those of Sobolevski in the Kunlun. The investigation of remains of former glaciation in the latter district is rendered especially difficult by the severity of subsequent erosion and the obscuring of all characteristic features under a heavy deposit of wind-blown loess; yet sufficient evidence was found of the existence of two separate epochs. The limit of even the greatest former advance was fixed at a much higher altitude than in other districts of Turkestan—relatively higher (3600 meters, as compared with 2500 meters) than the present limit. The distance between present and lowermost former termini averages less than 700 meters.

In connection with these glacial records of Turkestan, attention may be called to an article following Sobolevski's (same publication, pp. 56–100) describing traces of former glacial action in northeastern Mongolia, encountered by the geological expedition of M. A. Usov in 1914–1915. The glacial development in this region, as in Turkestan, appears to have been confined to the formation of separate glaciers, rather than of an ice sheet. The observations were too scanty and scattering to permit of any clear deductions as to the number of epochs of advance.

J. V. Fuller

AUSTRALASIA AND OCEANIA

The Site and Position of Sydney in Relation to Population. The accompanying map, Figure 1, shows the singular disposition of population around Sydney, Australia's largest city, now numbering a million people. It is reproduced from a paper by Griffith Taylor, "The Warped Littoral Around Sydney" (*Journ. and Proc. Royal Soc. of New South Wales*, Vol. 57, Part I, 1923, pp. 58–79). Dr. Taylor describes the distribution as viewed from an airplane circling the city on a 50-mile radius. "On the north our flight leaves the narrow coastal plain at Wyee. Thereafter for eighty miles along our circle we cross only one good road. . . . The next twenty miles crosses Bell's road . . . and brings us to the Katoomba tourist belt. Proceeding south for forty miles we notice the single settlement of the Yerranderie mines, before we reach the southern [railway] line near Balmoral. Another twenty miles stretch of uninhabited water reserves brings us to the narrow coast plain near Kiama, and here again a closely settled region is observed. Thus, excluding the shore, during a flight of over 150 miles, we have only crossed two narrow belts of settlement." Also striking is the symmetry of distribution about

an east-west axis. Explanation is to be found in the physical history of the region, which Dr. Taylor illustrates with orographical and geological sketch maps, a map of geographical regions, and a block diagram. The last is reproduced as Figure 1. The block diagram exhibits the notable symmetry about an axis running west from Botany Bay. Botany Bay, a drowned circular plain, is unlike any of the

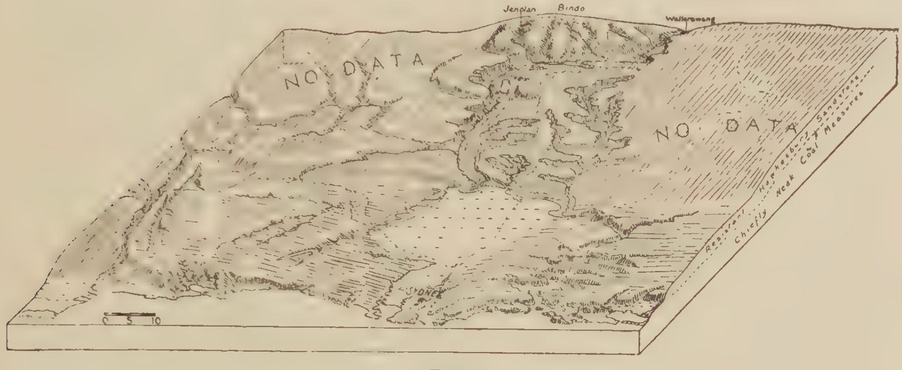

FIG. 1

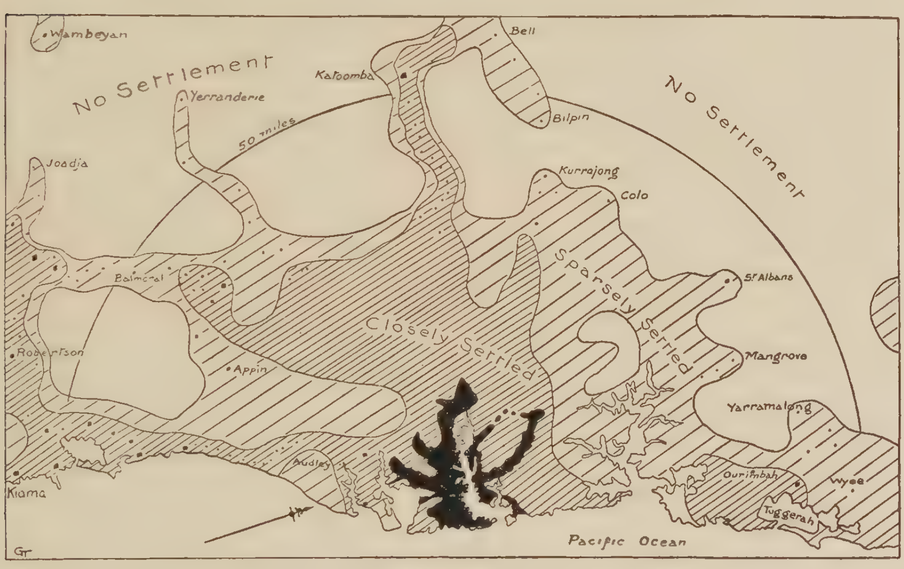

FIG. 2

FIG. 1—Block diagram of the warped littoral about Sydney, looking west. Reproduced from Figure 3 of Dr. Taylor's paper.

FIG. 2—Distribution of settlement about Sydney. Region of city streets black; region where centers are less than four miles apart closely ruled. (The arc is 50 miles radius.) From Figure 5 of Dr. Taylor's paper.

adjoining inlets. Previous to depression this area and the Wianamatta plains to the westward had not participated in the dominant movement of elevation which affected almost all the littoral. The Wianamatta plains is a gently rolling country developed on soft shales, moderately fertile and offering opportunity for close settlement. All around resistant and sterile sandstones constitute a barrier between Sydney and the interior.

Sydney itself occupies a hilly site. The city, especially the mercantile city, has spread along the little-warped south shore; the residential section tends to the northern, more elevated shore. The site is undoubtedly the best in the vicinity. Botany Bay does not have the facilities for deep water frontage, and Port Hacking, the estuary corresponding to Port Jackson south of the axis of symmetry, is shoaled by silt from numerous streams. Port Jackson also penetrates farthest into the plains area. Though Sydney is handicapped by the landward barriers it is favored in other respects of situation, as Mr. M. Aurousseau has described in an "interpretation" of Sydney in the *Sydney Morning Herald* (Dec. 20 and 27, 1924, and Jan. 3, 10, and 17, 1925). "Sydney is at a point that is suited to the distribution of population in eastern Australia, from Townsville to Melbourne; a point that has the character of a mathematical mean. It is near the middle point of the coast of New South Wales, and can receive with maximum efficiency from the minor ports to north and south. It is on a stretch of coast that is nearer to New Zealand than any other part of Australia but Hobart, and nearest to that part of New Zealand that has the most important dealings with the Pacific. It is a more suitable rendezvous for trade with the arc of islands from New Guinea to New Zealand than any place further north. This is due in part to the existence of the Barrier Reef, which impedes the decentralisation of island traffic, but in greater part to the fact that no place on the coast of Queensland has the other advantages of site and position that Sydney possesses. It is also on a great marine highway, the road from the Far East to Melbourne, and is the best terminus for American traffic. The position to seaward, then, is a splendid one. To landward it is not so good. The emplacement of Sydney is somewhat analogous to that of Rio de Janeiro, the superb gateway of a rugged and difficult hinterland."

The chief rival to Sydney is likely to arise in the north of the state, where industrial development is already foreshadowed in the Newcastle coal fields. Newcastle has the advantage of the best route to the interior, but the site is inferior to that of Sydney. Mr. Aurousseau points out "an unsuspected advantage of position" in that Sydney lies at the center of a semicircle about which are three coal fields—Newcastle, Lithgow, and Kembla—and thus within a ring of future industry. Here is another circumstance pointing to the evolution of Sydney not only as capital and commercial city but as a true metropolis.

Australian Problems in Human and Physical Geography. Mr. J. V. Daneš, professor of geography at the Charles University of Prague, Czechoslovakia, has returned from Australia, the scene of some of his earlier studies and where he has lately been acting as Consul General for his country. The results of his recent investigations are now being published.

In a paper entitled "Origin and Extinction of the Aboriginals of Australia" (*Země a lidé*, Vol. 50, Prague, 1924) Mr. Daneš approaches the problem of the origin of the aboriginal population from a morphological and paleogeographic standpoint. In accord with Griffith Taylor he thinks it probable that the Tasmanians crossed to Australia during the third or penultimate glaciation, the Australian aboriginals during the last one. Glaciation had ended and Bass Strait opened again before the latter had been able to reach southeastern Australia, hence the preservation of the Tasmanians on their island. The movements of these primitive paleolithic tribes is to be explained by the very different configuration of the land at the time of their migrations.

The author accepts Daly's views as regards the lowering of the ocean level during each glaciation by the accumulation of water in the form of ice on the continents ("The Eustatical Sinking of the Sea Level During the Glacial Epoch and the Distribution of Men," *Sborník československé společnosti zeměpisné*, Vol. 30, Prague, 1924). In assuming a lowering of sea level of about 60 or 80 meters at the

time of maximum of each glaciation land bridges would come into existence for the time being. Australia would be connected with New Guinea and Tasmania. At the same time the Asiatic continent would embrace Molengraaff's Sundaland, Sumatra, Java, and Borneo. Deep passages would still occur between the lesser Sunda Islands, Celebes, the Moluccas, and the western peninsula of New Guinea, but they are in a region of tectonic unrest and may well have come into existence only after the human migration.

The one great obstacle against the assumption of such a land connection is the profound difference between the Asiatic and Australian faunas. But it may be noted that mobile creatures, such as the dingo, certain mice, and man himself could avail themselves of the supposed bridges during a time too short for slower migrating forms. Furthermore, climatic conditions were then quite different. Following Penck's theory of the equatorward shifting of the climatic zones during glaciation, Daneš attributes desert conditions to the short-lived bridges between Asia and Australia.

Daneš also suggests that the many gaps in the prehistoric record point to a recent rise of sea level. Primitive man found most favorable living conditions along the seashores and river mouths. It is significant that kitchen middens are found only in regions of recent uplift. Rise of sea level would drown traces of such occupation, and on coasts with heavy tides and strong sedimentation it would seem hopeless to find them. Exceptionally favorable conditions, however, would appear to occur along the Dinaric shores of the Adriatic. There are practically no tides; the rivers from the karst carry practically no waste; cold submarine springs prevent the development of a rich marine life. At the same time these calciferous waters precipitate travertine, encrusting such remains as lie on the present sea floor. The transparent waters of the Adriatic permit observations to be made from the surface, and it is here that conditions would seem most favorable for solving the enigma of man during the Ice Age.

Julie Moscheles

POLAR REGIONS

The Amundsen-Ellsworth Polar Flight. The Amundsen-Ellsworth Polar Expedition returned safely to Spitsbergen on June 18 after a month's absence. The plans of the expedition were briefly described by Mr. Ellsworth in the April number of the *Geographical Review*. Meteorological conditions were naturally of prime importance and the careful preparations included analysis of weather reports received from the regions circling the Arctic by the younger Bjerknes and another Norwegian meteorologist. On their advice the flight began May 21, the planes taking off from the base at King's Bay at 5 P. M. An hour later fog was encountered and the planes rose to a height of 3100 feet and met a stiff breeze from the northeast. Through rifts in the fog glimpses were had of the polar pack, reached in 2 hours of flying time. At 8 P. M. the fliers passed out of the fog to see spread below them "a spectacular sheet of snow and ice" everywhere marked by heavy pressure ridges. Thenceforth conditions of visibility were excellent. An observation at 10 P. M. showed the wind had carried the fliers too far westward. At 1 A. M. half the gasoline had been used. The planes were then above a large lead, the first of any size seen, and the only suitable landing place amid the jagged ice. Descent was made for bearings. The N25 was immediately locked in by two masses of ice, and in a short time the N24 was also gripped. The position was latitude 87° 44′ N. and longitude approximately 10° 21′ W. On the flight 1000 kilometers (611 miles) had been covered in 8 hours at an average speed of 150 kilometers (93 miles) an hour, the headwind thus having held back the planes 200 kilometers.

At this point the expedition was 300 miles from Greenland, 450 miles from Cape Columbia. It was judged that the best hope lay with the planes, but in the event of being unable to get off it was decided to attempt the journey on foot to Columbia rather than the inhospitable Greenlandic coast. With rations cut down to a minimum the six members of the expedition set themselves to the task of releasing the N25 and preparing a runway, a task rendered extremely difficult by the movements of the ice. Five attempts failed. It took a week to clear 500 yards on the floe, from which the sixth and successful attempt was made. Temperature conditions also were unfavorable; the floe was covered with 3 feet of water-soaked snow. "We found we could tramp the snow under foot. Until June 13 we trod ceaselessly up and down the swathe." Fortunately the temperature dropped, and on June 15 at 10.40 A. M. the N25 took the air. The course was laid farther eastward. A good deal of fog was encountered, but in 8½ hours North Cape was reached, the landfall being the northern extremity of North-East Land.

The chief scientific result of the expedition is the bearing on the question of land in these regions. On the northward flight 100,000 square kilometers of unexplored area were observed, on the return 60,000 without such indication. At the point of descent, 160 miles from the pole, two soundings by Behmlot apparatus showed a depth of 3750 meters (2050 fathoms), which is in accord with Peary's observation 5 miles from the pole (1500 fathoms without touching bottom). This goes to confirm Nansen's idea of a deep polar basin.

Animal life seen by the expedition was limited to a glimpse of a single seal in a lead in the ice and three birds, two geese, and an auk flying northwestward. The latter, says Amundsen, suggests that land lies in that direction.

While on the ice observations were made on the drift and on magnetic variation and the meteorological situation. Among other problems on which the expedition sheds light is that of aerial navigation, a matter briefly discussed in the following note.

Aerial Navigation Near the Pole. The three recent expeditions to the Arctic, namely, the Amundsen-Ellsworth Expedition, the Oxford University Arctic Expedition, and the MacMillan Arctic Expedition under the auspices of the National Geographic Society, have shown the question of aerial navigation to be one of peculiar interest. The problem is beset by theoretical and mechanical difficulties. It may be divided into two parts: first the problem of steering a course, and second, the problem of finding geographical position.

Steering by magnetic compass near the poles is for various reasons very impracticable, chiefly because of the lack of knowledge of the magnetic declination, and also because the horizontal component of the earth's magnetism is weak. Captain F. Tymms, a member of the Oxford expedition, in one of a series of articles on this expedition appearing in the July and August numbers of the Royal Geographical Society's journal, is of the opinion, however, that the magnetic compass is not entirely useless but at the same time suggests that the ideal equipment on future occasions would be a sun compass with a magnetic compass in reserve. It was in this way that the problem of steering a direct course was more or less overcome by Amundsen, who used a solar compass made specially by Goerz, which he found to operate "with entire satisfaction." This instrument, provided the flight is maintained on a given meridian, indicates to the navigator true north, for once the instrument is set a clockwork mechanism automatically corrects for the constant change in the sun's hour angle. Information as to how corrections for the rapid change in the latitude of the airplane were made is not yet available, and hence it is assumed that this was done personally by the pilot as the flight proceeded. The corrections due to the change in the sun's declination were doubtless neglected, as these would be considerably smaller than the probable errors in the navigation itself.

The MacMillan expedition also proposed using a solar compass but of a different type and designed by Mr. Bumstead of the National Geographic Society. This was satisfactorily tested before the expedition left Wiscasset in Maine, but otherwise no information is forthcoming as to its efficiency.

It appears likely that determination of position while flying near the poles will never be made with the accuracy obtainable by explorers on the ground. The reason for this is obvious when one considers first of all the extreme difficulty of observing accurate altitudes of a celestial body from a rapidly moving airplane with a sextant, the only instrument at all practical for the purpose, and secondly the fact that as a rule the sun will be the only available body to observe on and that therefore only one position line can be determined at a time, all of which makes it necessary for the navigator to depend to a large extent on his dead reckoning. However, the problem of determining the distance and direction flown is being rapidly overcome with such instruments as speed and drift indicators, course and distance indicators, and smoke bombs. These instruments are described, together with the whole problem of aerial navigation and position-finding near the poles, in two excellent articles by Lieutenant Commander Byrd (in charge of the aerial operations on the MacMillan expedition) and G. W. Littlehales in the August number of the *U. S. Naval Institute Proceedings* (Vol. 51, No. 270).

From the foregoing remarks it is apparent that one solution of the difficulty of position finding near the poles would be for the airplane to make a landing when necessary and for observations to be made on the ground. But this is an extremely hazardous undertaking in the polar regions, as witness the experiences of the Amundsen-Ellsworth expedition. It is principally for this reason that experienced authorities are tending towards the opinion that the dirigible airship is the practical vehicle for polar flights.

It is of interest to record that Mr. Ellsworth, previous to departing from New York in April, availed himself of the facilities provided at this Society's School of Surveying for studying and discussing this difficult question of aerial navigation near the poles.

Argentine Interest in Antarctic Exploration. Guillermo Hoxmark in the article "La Argentina y las exploraciones antárticas" (*Anal. Soc. Científica Argentina*, Vol. 97, 1924, pp. 119–155) advocates Argentine participation in Antarctic exploration and puts forward practical suggestions for the organization and conduct of an expedition under the auspices of the republic. He commences with a historical survey from the voyage of Pedro Fernández de Quirós, who sailed from Callao in 1605 and discovered the South Shetlands, to Shackleton's last expedition. Next Mr. Hoxmark outlines the explorations yet to be undertaken in order to make clear the geography of Antarctica. Graham Land needs to be explored to the south of latitude 68° S. to determine whether it is an island or a part of the Antarctic continent. The coast from Charcot Land to Edward VII Land is unknown. There are large breaks between Cape Adare and Weddell Sea in which the character of the coast is unknown. The region of about longitude 70° W. is the region which offers the greatest probability of notable discoveries. If the unknown land is a continent then the mountains rising to 5000 meters encountered by Amundsen and Scott are the "Cordilleras Antarcticas" corresponding with those of South America, and it is to be expected that between Graham Land and Ross Sea there lies a chain of islands like those along the coast of Chile. The land on the other side may slope more gently toward the Atlantic, like the Pampas of Argentina. The projection of Graham Land toward Tierra del Fuego and the existence of volcanoes more or less of the same age as those of the southern Andes strongly suggest that these southern mountains are an extension of the Andean chain. Moreover, the remains of animals and plants of the Cretaceous epoch when

the climate was mild likewise suggest a former connection of South America with the Antarctic land surfaces.

Mr. Hoxmark then passes to the question of the best years for exploration and draws a curve derived from Mossman's collection of the observations of the duration of ice at Laurie Island. His curve appears to show that the duration of ice lags behind the inverted sun-spot curve about two years. The minimum amount of ice occurs about two years after sun-spot maximum, and the maximum amount of ice about two years after sun-spot minimum; so that if Shackleton, for example, had gone south in 1919 instead of 1915 he would have had a much better chance of success. This conclusion agrees with my own investigations, which show an excess of pressure in the latitude of South Georgia during years of sun-spot maximum, an increased air circulation in high latitudes, and an increased amount of floating ice, indicating that there must be a breaking up of the ice farther south.

Hoxmark, referring to Amundsen's introduction of the airplane into polar work, anticipates the use of the airplane in future Antarctic exploration and points out that it will be easier to land over the snow fields of the Antarctic continent than over the broken ice of the north polar basin. In conjunction meteorological factors, including wind and cloudiness, are discussed.

It may be remarked that one of the special disabilities in Antarctic, as compared with Arctic, exploration has been the difficulty of utilizing the pack for travel, as Wright and Priestley point out in their volume on Glaciology. Use of the airplane in the South Polar regions may soon be put to the test. It is reported that Captain George H. Wilkins, who was a member of the Canadian Arctic Expedition under Stefansson, will be leader of an aerial expedition to Graham Land in 1926.

Hoxmark also points out the need for specially built ships with V-shaped bottoms, on the lines of the *Fram* and the *Maud*, which are better able to withstand the crushing strain of adjacent ice floes than are ships with the usual U-shaped bottoms.

Finally he urges the importance of meteorological and magnetic observations in the far south and points out the opportunity for the Argentine government to take a leading part in such explorations.

H. H. Clayton

The Expedition of the Royal Research Ship "Discovery." Since its inception on an extensive scale in 1909 the whaling industry of the Falkland Islands Dependencies has advanced rapidly. Figures for the season 1922–1923 show an output of oil double that of the pre-war average in quantity, quadruple in value. It is noteworthy that this gain has been made chiefly as the result of more economic methods of utilization in consequence of the stringent regulations introduced in 1921 by the Falkland Island Government which has controlled the industry from the start. Conservation measures, however, could be still more effectively employed if the habits and migrations of the whales and the reasons for their fluctuating numbers were better understood. With this objective there was organized the *Discovery* expedition (*Nature*, No. 2903, Vol. 115, 1925, June 20, pp. 950–951).

The expedition is subject to the instruction of the Secretary of State for the Colonies. The cost is met entirely from public revenues raised in the Dependencies of the Falkland Islands. Dr. Stanley Kemp is Director of Research. The vessel, the Royal Research Ship *Discovery*, built for Captain Scott in 1901, has been refitted and completely equipped for the work. The expedition sailed from England in July and will be occupied for two years. It was planned to begin work in the Gulf of Guinea, thought to be the northern limit of migration of southern whales. After touching at Cape Town the course will be laid for South Georgia, where a laboratory has been established at Cumberland Bay. Thence the expedition will proceed to the South Shetlands.

As said above, the prime object is to secure information on whales, especially those species forming the basis of the industry now flourishing in the waters of South Georgia and the South Shetlands. Geographical exploration is not included in the program; but efforts will be made to improve our knowledge of the coast lines visited, and surveys will be made of the harbors frequented by the whalers. Furthermore, the ship is carrying two sets of echo-sounding apparatus, for shallow and deep water respectively, which it is hoped will afford valuable data.

PHYSICAL GEOGRAPHY

The Relation of Current to Wind. The wind has always been regarded as one of the principal causes of ocean currents, and it had been taken for granted that a wind blowing steadily over a wide stretch of water gives rise to a current which sets with the wind. This opinion received support from the mathematical investigation of the question published by Zöppritz ("Hydrodynamische Probleme in Beziehung zur Theorie der Meeresströmungen," *Annal. der Physik und Chemie*, Vol. 3 (N. S.), 1878, pp. 582–607). From this investigation it was concluded that a steadily blowing wind will, through friction, bring about a surface current in the direction of the wind; this surface layer will in turn put in motion, in the same direction, a lower layer of water until finally the whole mass of water from top to bottom will be flowing in the direction of the wind. These conclusions were accepted for many years, and it was only at the beginning of the present century that attention was directed anew to the matter. In studying the observations made on the drift of the ice during his North Polar expedition, Nansen was struck by the fact that for any given period the drift of the ice was almost invariably to the right of the corresponding wind resultant.

Nansen suspected that this deviation of the ice drift to the right of the wind was due to the deflecting force of the earth's rotation, and he therefore requested V. W. Ekman, the Swedish mathematician, to investigate the matter mathematically. In Zöppritz's work the effect of the earth's rotation was not considered, the assumption undoubtedly being that, since the velocities of wind-driven currents were never great, the effect of the earth's rotation would be so small that it might be completely disregarded. Ekman, however, introduced this deflecting force into his equations and on the assumption of a large body of water of infinite depth arrived at a number of unexpected results, one of which was that the current brought about by the wind, on the surface, sets 45° to the right of the wind in the northern hemisphere and 45° to the left in the southern hemisphere ("On the Influence of the Earth's Rotation on Ocean Currents," *Arkiv för Matematik, Astronomi, och Fysik*, Vol. 2, No. 11, 1905). Near the coast the direction of the wind-driven current is obviously very greatly modified by the coast. But it is only near the coasts of the northern hemisphere that systematic current observations have been made, and these show in general a deflection to the right of the wind. For example, current observations made by the Coast and Geodetic Survey on the lightships stationed along the Atlantic and Pacific coasts of the United States show that on the former coast the deviation is about 20° to the right of the wind, while on the latter coast it is about 15° to the right.

In an article on "The Relationship Between Current and Wind" (*Quart. Journ. Royal Meteorol. Soc.*, Vol. 50, 1924, pp. 113–119) C. S. Durst attempts a verification of Ekman's theory in the open sea. No systematic current observations are at hand for the open ocean, but Durst makes use of the navigator's determination of the position of his ship as he charts the course of his vessel across the trackless sea. Each day at noon the position of the ship is determined by means of astronomical observations. The distance steamed by the ship between these noon observations

is also determined by means of a patent log or by means of the number of revolutions of the propeller. This, together with the course steered, enables the navigator to calculate the "dead reckoning" position of his ship, or the position the ship would be in if unaffected by currents. For each day, therefore, the difference between the dead reckoning position and that determined by the astronomical observations gives the direction and velocity of the current for the preceding twenty-four hours.

Durst analyzed the relation of current to wind in various tracts of the ocean, and the result that stands out immediately is the deviation of the current to the right of the wind in the northern hemisphere and to the left of the wind in the southern hemisphere. This deviation varies somewhat, as is to be expected from the character of the observations, but in general it may be said to approximate 40°. The velocity of the wind-driven current Durst found to be directly proportional to the velocity of the wind and inversely proportional to the square root of the sine of the latitude.

H. A. Marmer

HUMAN GEOGRAPHY

Geographical Research and the Tropics. Fear that the time is approaching when the agricultural lands of the temperate zones will no longer suffice to support the white populations of the world is increasingly turning attention equatorward. Some even claim to see in the unoccupied spaces between the tropics an outlet for surplus white peoples. Indeed, one of the primary geographical questions of the future is whether or not white races can establish prosperous and populous settlements at low altitudes under the tropical sun, but it is a question of such complexity that we venture to believe only time and long experience, even suffering, will definitively answer it.

Professor J. W. Gregory in his address last year as president of Section E (Geography) of the British Association for the Advancement of Science at the Toronto meeting asserted that "the conclusion that the white man is not physiologically disqualified from manual labour in the tropics and may colonize any part of Australia simplifies inter-racial problems, as it provides an additional outlet and spacious home for the European race." This seems optimistic beyond the safety point. Along with certain other problems discussed by Professor Gregory (among them the American negro question) this one is surely neither as simply nor as easily solved as he argues and implies (J. W. Gregory: Inter-Racial Problems and White Colonization in the Tropics, *Rept. British Assn. for the Advancement of Science No. 92* (Toronto, 1924), London, 1925, pp. 125–147; also printed in *Pan American Geologist*, Vol. 42, 1924, pp. 81–111, and in *Scottish Geogr. Mag.*, Vol. 40, 1924, pp. 257–282).

Before we can come to conclusions in these matters there is much need for what Mr. W. R. Dunlop, in a paper delivered before the Royal Society of Arts, calls "research in economic geography and industrial and administrative efficiency with relation to the development of the tropics." Dunlop does not try to generalize about matters concerning which, after all, we have relatively few data to guide us. He rather suggests and illustrates possible methods of approaching these subjects and of acquiring the data necessary to deal with them. "The main issue," he says, "is the point of view, the philosophy, and the nature of the kind of research I am advocating." He holds "that a systematic study of the British tropics along the lines suggested, . . . would not only assist in economic development, but would intellectually increase our [i. e. British] world prestige, cost very little, and lead in the end to a much better understanding and closer sympathy . . ."

Mr. Dunlop sharpens the focus of his discussion of broader principles by the comparison of two tropical British colonies which superficially resemble each other in many respects but are at opposite poles as far as population and economic development are concerned. These are British Guiana and British Malaya. Both are approximately the same size; "both lie within a similar range of latitude . . . and what is of greater importance, they lie . . . in the two great tropical regions of maximum rainfall of over 80 inches per annum." Vegetation, diseases, soil, water power, a mountainous interior—these are common to both. But whereas British Malaya has a population of some 3,000,000, British Guiana has only 300,000. Whereas agriculture, forestry, and mining are actively pursued throughout the greater part of the former, most of the latter is a wilderness and much of it is unexplored.

Why should these differences prevail? What may be done to improve conditions in both colonies and especially in the more backward one?

The answer to the first question is to be sought mainly in geography and on the whole is not difficult, although the same question applied to the comparison of other regions might not always be so readily answered. The low coasts and shallow river mouths of British Guiana cannot be approached by large ships, and the rivers leading into the interior are difficult of navigation even for small craft. British Malaya, on the other hand, occupies a peninsula and has several fine harbors which render easy actual or potential access to all parts of the country. Furthermore, the mineral resources of British Guiana have "not been so lasting and extensive" as those of British Malaya; and, finally, while British Malaya lies on one of the main trade routes of the world, British Guiana is isolated from the channels of the world's affairs.

The second question involves essentially "investigations designed to enable us to make suggestions for improvement" in the relative efficiency of industries (including, of course, agriculture), "without any considerable increase in capital expenditure." These investigations must take into consideration such matters in the economic field as relative costs of production and of living, relative efficiency of labor ("tropical laziness," for instance); and in the administrative field, matters of land administration, forestry, public health, and scientific research. Efficiency in tropical administration, Dunlop believes, will come mainly from economic studies, inasmuch as it is mainly an economic problem. Throughout these economic studies, however, he insists that the geographical factor be kept to the fore. "The fundamental idea," he says, "is regional" (W. R. Dunlop: Economic Research in Tropical Development With Special Reference to British Guiana and British Malaya, *Journ. Royal Soc. of Arts*, Vol. 73, 1925, pp. 311–334).

The solution of the problems of the utilization of the tropics for the best interests both of white and colored races alike can come only through the pursuit of prolonged research similar to that which Dunlop suggests. As yet we are only on the fringe of such investigation.

HISTORICAL GEOGRAPHY

Travel in the Middle Ages. The recent publication in two small volumes of passages from medieval writings gives us a view of the character of medieval travelers and the conditions under which their wanderings were made. E. L. Guilford in his "Travellers and Travelling in the Middle Ages" (*Texts for Students*, No. 38, The Sheldon Press, London, 1924) aims to supplement the material so charmingly presented by Former Ambassador Jusserand in "English Wayfaring Life in the Middle Ages (XIVth Century)." Texts are quoted without comment covering a wide range of topics: crusades, pilgrimages, the traveling merchant, types of wayfarers (students, pirates, tinkers, gypsies, vagabonds), inns, dangers of the

road, outlaws and sanctuary, and witchcraft. The modern tourist will be entertained by a list of recommendations which William Wey prepared in the fifteenth century for intending pilgrims to the Holy Land. These suggestions are above all practical, reminding one of the introductory chapters of Baedeker. On arriving at Venice the pilgrim is advised: "Fyrste yf ye goo in a galley make yowre covenante with the patrone by tyme, and chese yow a place in the seyd galey in the overest stage, for in the lawyst under hyt ys right smolderyng hote and stynkynge. . . . Also that yowre patrone weff yow every day hote mete twyes at two meyls. . . . Also by yow a cage for half a dosen of hennys or chekyn to have wyth yow in the galey. For ye schal have nede un to them meny tymes."

The things that before all else interested the typical medieval pilgrim are illustrated in E. M. Blackie's "The Pilgrimage of Robert Langton Transcribed With an Introduction and Notes" (Harvard University Press, Cambridge, Mass., 1924). Until a copy was recently found in the Library of Lincoln Cathedral, it was believed that none existed of the original of Langton's little book. The black-letter reprint in Archdeacon Blackie's edition, resembling (but not a facsimile of) the original, from the typographical point of view does credit to the Harvard University Press and preserves the early sixteenth-century atmosphere. Langton was a British ecclesiastic of the old order who made the pilgrimage to the shrine of St. James of Compostella and incidentally journeyed widely through Spain, France, and Italy. His account is bald and dry. He mentions little besides the religious relics preserved at the various places he visited. About all that he writes of Compostella, for instance, is: "There is saynt James buryed. Also there is the heed of saynt James the lesse. Also pieces of the holy crosse. . . . Also bones of saynt Gregory. . . . Also a tothe of saynt Syluester with many other relykes." His obliviousness to anything else of interest forced Archdeacon Blackie to the conclusion, perhaps a little harsh, that Langton "was a man of dull mind." But before accepting this judgment it is well to remember that Langton's purpose was undoubtedly to provide a practical guide for those who were seeking relics. At all events his book gives us an admirable idea of the sort of thing that attracted the pious throughout the Middle Ages and that even now in many parts of the world is not without its allurement. An attitude of healthy scepticism toward the value of relics, however, was growing in Langton's time and is shown in some amusing passages from Erasmus quoted by Archdeacon Blackie in his introduction.

For references to other recent publications dealing with the history of travel at different epochs, see the *Geographical Review*, Vol. 11, 1921, pp. 628–629, and Vol. 13, 1923, pp. 149–150 and 655.

Cartographic Tendencies in the Seventeenth and Eighteenth Centuries. Two tendencies are apparent in the cartography of the seventeenth and eighteenth centuries. One led to the production of magnificent maps and atlases for sale to map lovers—or, at least to those who could afford them. The Dutch atlases of the Blaeus in the seventeenth century were truly works of art, sumptuous beyond any atlases published at the present time. From the point of view of accuracy, however, the makers of commercial maps of this sort were hampered by the lack of astronomically and trigonometrically determined points upon which to hang the topography and also by a prevalent prejudice against the publication of topographical details which might be of value to an enemy. The second tendency, on the other hand, led to the carrying through of accurate surveys for scientific, administrative, and, above all, for military purposes. The maps based on these surveys, rather than the work of the atlas makers, were the predecessors of the great national topographic maps of the nineteenth and twentieth centuries.

Johann Baptista Homann was a famous commercial map maker. In 1702 he established a cartographical workshop and publishing house in Nuremberg, an

enterprise which proved highly lucrative both to himself and his heirs. The two-hundredth anniversary of his death (1724) is commemorated in a recent brief biography by Wilhelm Eberle (Der Nürnberger Kartograph Johann Baptista Homann: Zu seinem 200. Todestage: Ein Lebensbild, *Mitt. und Jahresberichte der Geogr. Gesell. in Nürnberg*, Vol. 3, 1923–24, Nuremberg, 1924). Prior to Homann's day, French and Dutch maps had dominated the German markets, but Homann was soon able to replace these foreign maps by "equally good but cheaper German products." His maps were all of uniform size, in order that they might readily be combined in atlases. Unlike the Dutch cartographers, Homann consistently placed north at the top of the sheet, though his maps were uniform neither in scale nor projection. In representing relief he abandoned the earlier caterpillar style of showing hills, substituting a rude form of hachuring which gives the appearance of a bird's-eye view of the landscape. In some of the later maps the relief was shaded as if illumined by oblique rays of light. Eberle observes that "many sheets, particularly some of those dating from the last decade of Homann's life, reveal an astonishingly correct representation of the form of the countryside."

In point of time Homann's maps fall about midway between two surveys which illustrate the second cartographic tendency—the evolution of administrative and military mapping.

The first of these surveys was the work of the prior of the Augustinian convent at Fürstenfeld, Styria, between 1601 and 1605. The southern frontiers of the Austrian domains at this time were under a constant menace of Turkish attack, and hence the need of accurate maps was felt more keenly here, perhaps, than in other parts of Europe. In 1603 the Archduke Ferdinand of Austria commissioned Prior Johannes Clobucciarich to carry out a survey of Inner Austria (Styria, Carinthia, Carniola, Gorizia, and Northern Istria), but Clobucciarich's death intervened before the work could be brought to completion. The topographer's documents, however, consisting of letters, notes, field sketches, panoramas, and sketch maps, have been preserved and recently made the subject of a study by Fritz Popelka (Die Landesaufnahme Inner-Österreichs von Johannes Clobucciarich, 1601–1695, Graz, 1924; see also *Mitt. Geogr. Gesell. in Wien*, Vol. 66, 1923, pp. 101–106). This monograph is accompanied by twenty-nine plates, photographic reproductions of the more interesting of Clobucciarich's sketches, particularly of those representing the many strongholds which dominated the borderlands of Inner Austria.

Clobucciarich's incompleted work has somewhat more than mere local interest. It illustrates the necessarily crude topographical methods of what has been called the pre-geodetic period in the history of cartography (see *Geogr. Rev.*, Vol. 14, 1924, pp. 146–147). As careful as was possible under the circumstances, his survey was based not upon instrumental observations—though Clobucciarich made use of a compass for orientation—but upon the piecing together of data derived from sketches, panoramas, and sketch maps made during extensive wanderings through the country and the correlating of these by means of distances between important centers roughly measured along roads. What was lacking in topographical accuracy was made up for by the detailed rendering of the appearance of towns, villages, and castles.

Clobucciarich's methods were antiquated by the latter half of the eighteenth century. The advance in mapping is illustrated in a survey of the Electorate of Hanover begun in 1764 by the military engineers of that state with a view to finding the best route for a canal between the Elbe and the Weser, and extended to cover the entire Electorate under a decree of the Elector, King George III of England. The results of the survey were embodied in a manuscript map in 165 sheets on a scale of 1 : 21,333⅓ (approximately three inches to one mile). Owing in part to the high cost of copper engraving and in part to the prevalent prejudice against the publication of topographical details, the map was not reproduced at the time. Re-

cently, however, the Historical Commission for Lower Saxony has undertaken to produce a reduced photographic facsimile on a scale of 1:40,000. Twenty of the 165 sheets have appeared, accompanied by a brief explanatory text by Professor Hermann Wagner of the University of Göttingen. Further sheets will be published as subscriptions for the work can be raised (Topographische Landesaufnahme des Kurfürstentums Hannover von 1764–86 (in 1:21333⅓): Lichtdruckwiedergabe im Massstab 1:40000, Part I, Historical Commission for Lower Saxony, Hanover, 1924).

Wagner points out that this map "is one of the most valuable cartographical monuments of the period when surveys of large areas were still rarities." The scale is much larger than that of either of two famous contemporary maps, the Schmettau map of the Prussian territories east of the Weser (1767–1780: 1:50,000) and the Cassini map of France (1750–1790: 1:86,400). Elevations are represented by hachure lines and the heavy shading of the steeper slopes. Streams are shown in blue. A variety of symbols is employed to distinguish between different types of terrain: deciduous and coniferous woods, meadows, plowland, moors, pastures. Roads and buildings are colored in various tints of red. The scale is large enough to bring out the street plans of the towns. Several different types of road are differentiated in the open country; and windmills, ruined castles, watchtowers, and other buildings are indicated by appropriate conventional signs. The Commission bringing out the reproduction is performing a signal service not only to students of Hanoverian history in the eighteenth century but to all who are interested in the broader aspects of the history of cartography.

GEOGRAPHICAL NEWS

Award of the Explorers Club Medal to Lieutenant Lowell H. Smith. The Explorers Club of New York has awarded its medal to Lieutenant Lowell H. Smith, leader of the U. S. Army Round-the-World Flight. This first aerial circumnavigation of the globe, it may be recalled, was completed at Seattle, Wash., on September 28, 1924, in six months all but a week, a distance of 27,544 miles being covered in 351 hours of flying time. (An official account of the flight appeared in the November, 1924, number of *Current History*.)

The Explorers Club Medal has been bestowed only a limited number of times, earlier recipients including Peary, Farabee, Rondon, and Stefansson. The presentation to Lieutenant Smith was made at Los Angeles on July 9, by Dean Bruce of the Southern Branch of the University of California. The sentiment of the award was voiced by Dean Bruce: "When we consider the untiring energy, the inexhaustible resourcefulness, the unbroken courage with which you and your colleagues brought your airplanes through a half year of blizzards, fogs, typhoons, monsoons, sand storms, from our continent back to our continent; when we consider the significance to us all of your circumnavigation of the globe, by airship, four hundred years after Magellan's circumnavigation of it by sailing ship, then we may feel ourselves greatly privileged to be able to present to you today this medal of the Explorers Club, honoring the Pathfinder of the Air."

Honor to Dr. Edwin R. Heath. Dr. Heath, whose services to Bolivian exploration are commemorated in the branch of the Beni that bears his name, has received a further honor at the hands of the Bolivian government. This is election to the Order of the Condor, a new order of merit created by Bolivia as a centennial memorial. Dr. Heath was elected a Corresponding Member of the American Geographical Society in 1924 (see *Geogr. Rev.*, Vol. 14, 1924, p. 467).

Obituary

William Curtis Farabee. William Curtis Farabee, Curator of the American Section of the University Museum, Philadelphia, died at Washington, Pa., on June 24, from pernicious anemia consequent on hardships sustained in his several South American journeys. Dr. Farabee's notable series of explorations in this field commenced with his leadership of the De Milhau-Harvard expedition (1906–1908), the results of which were published as "Indian Tribes of Eastern Peru" (*Papers of the Peabody Museum of American Archeology and Ethnology, Harvard University*, Vol. 10, 1922).

The second expedition, 1913–1916, was made under the auspices of the University Museum, Philadelphia. The expedition visited four widely separated areas mainly in the Amazon basin: the Guiana highlands, the Ucayali River in Peru, the island of Marajó at the mouth of the Amazon, and a section between the Tapajóz and Xingú Rivers. The narrative of the expedition published in the *Museum Journal* and elsewhere (see *Geogr. Rev.*, Vol. 3, 1917, p. 149, and Vol. 4, 1917, pp. 397–398) contains many interesting geographical observations, as for instance the too brief reference to the country penetrated between the Tapajóz and the Xingú, where Dr. Farabee approached from the north the unknown region that Colonel Fawcett proposes to enter from the south. Fine collections of archeological and ethnological material were secured. Results of this expedition are Volumes 9 and 10 in the Anthropological Publications of the University Museum, Philadelphia, "The Central Arawaks" (1918) and "The Central Caribs" (1924) respectively.

Another expedition to Peru was undertaken in 1921–1923 and important material obtained, which however has not been worked up. Dr. Farabee also acted as one of the ethnographers to the American Commission to Negotiate Peace, Paris, 1918–1919.

GEOGRAPHICAL REVIEWS

THE BRITISH EMPIRE'S RESOURCES

The Resources of the Empire: A Business Man's Survey of the Empire's Resources Prepared by the Federation of British Industries. Each volume containing a foreword by H. R. H. the Prince of Wales and a general introduction by Sir Eric Geddes. Indexes. 10 vols. in 12. Vol. 1, Food Supplies, by J. R. Ainsworth-Davis: Part I, Crops and Fruits; Part II, Meat, Fish, and Dairy Produce; Vol. 2, Timber and Timber Products, Including Paper Making Materials, edited by S. J. Duly; Vol. 3, Textile Fibres and Yarns, by J. S. M. Ward; Vol. 4, Fuel, edited by G. W. Andrew; Vol. 5, Rubber, Tea, and Cacao, With Special Sections on Coffee, Spices, and Tobacco, compiled and edited by W. A. Maclaren; Vol. 6, Leather, Hides, Skins, and Tanning Materials, by E. C. Snow; Vol. 7, Chemicals, by A. W. Ashe and H. G. T. Boorman; Vol. 8, Part I, Ferrous Metals, by M. S. Birkett; Part II, Non-Ferrous Metals and Other Minerals, by N. M. Penzer; Vol. 9, Oils, Fats, Waxes, and Resins, by E. R. Bolton and R. G. Pelly; Vol. 10, Communications, by W. T. Stephenson. Ernest Benn, Ltd., London, 1924. £7, 7s. 10 x 7½ inches.

On the occasion of the British Empire Exhibition at Wembley the Federation of British Industries published a series of volumes which constitute a valuable source of data on the economic situation of the British Empire and on the possibilities of further development of its commerce and industry.

Since the war the economic situation of the Empire has been greatly changed. Trade with the Orient and South America has fallen off, as is the case with several other countries where English importations encounter an ever rising tariff barrier. On the other hand, the Empire has seen its production capacity and number of workers increase. A reorganization of commercial policy was in order which should seek to integrate metropolis and dominions into a unit capable of furnishing all the necessary materials for its own subsistence and also of absorbing as much as possible of the goods manufactured.

The statistics for 1923 show that importations into the metropolis from the various parts of the Empire have increased since the war while exportations from the metropolis to the dominions have remained at about the same value.

TABLE I—PERCENTAGES OF IMPORTS AND EXPORTS

COUNTRY	IMPORTS TO GREAT BRITAIN		EXPORTS FROM GREAT BRITAIN	
	1913	1923	1913	1923
British India	6.3	6.0	13.4	12.2
Self-Governing Dominions	13.3	16.3	17.5	18.0
Other British Countries (except Hongkong)	5.3	5.3	5.4	5.7
Europe	40.4	33.2	34.4	34.2
United States	18.4	19.6	5.6	8.0
South and Central America	10.0	10.8	10.6	8.8
Other Countries	6.3	8.8	13.1	13.1

Now, the consumption per head of British products is very unevenly distributed: feeble in the thickly populated territories of India and British Malaysia, £0.2 and £0.5, it rises to £12.3 in New Zealand, £7.8 in Australia and is £2.3 in Canada and £2.1 in South Africa. This inequality has nothing surprising in it, and the authors of the several works in the series do not fail to point out the field for expansion thus offered in the different parts of an empire that in 1921 furnished 8.5 per cent of the world's production of copper, 22.9 of the lead, 42.2 of the tin ore, and 77.1 of the wool.

The metropolis has attained an economic development permitting it to play a highly efficient rôle in this vast British association; but it is necessary that the buying power of the Dominions should be increased as their productive power grows, and for promotion of the latter the metropolis must develop its consumption of Dominion products.

As regards purchasing power the dominions of the tropical zone must be distinguished from those of subtropical and temperate zones. For the former, in which the white population is limited in numbers and power of work, one must especially depend on capital and British materials while fostering native needs. For the latter the first effort must be rapid increase of the white population; this already increases, but it is useless to stimulate immigration unless opportunity for labor exists: call for labor and development of resources go hand in hand.

Great Britain has then a difficult problem to solve, and it is to aid in the solution that this series of volumes has been published. True, perfection cannot be claimed for this work; but inaccuracies revealed can be corrected and data completed in revised editions, which may perhaps follow.

In a brief review it would be impossible to give a survey of the 12 volumes, but the following notes on one of them selected at random will give some idea of the scope of the work.

The volume "Ferrous Metals" of 165 pages (including index) commences with a historical survey of the metallurgical industry, an excellent résumé of the question illuminated with very useful statistical tables. The author then passes in review the various sides of the problem, entering into the matter in detail, as is shown by the titles of some of the 17 chapters: The Raw Materials of the British Iron and Steel Industry; Pig Iron; Wrought Iron; the Sheffield Industries; Tinplates; Rails, Tyres, and Axles. The conclusion compares the metallurgical situations in the world market of the United States, British Empire, France, and Germany. The author, remarking on the increase in production in the United States and France, ends by declaring that Great Britain must inevitably continue to make steel as she did before the war, for she is the only country with suitable coal supplies on the coast to which foreign ore can be brought by sea and the product reshipped.

M. Lebrun

Life and Thought in India

The Earl of Ronaldshay. **India: A Bird's-Eye View.** xiii and 322 pp.; map, ills., index. Houghton Mifflin Co., Boston and New York, 1924. $5.00. 9 x 6 inches.

The Earl of Ronaldshay. **Lands of the Thunderbolt: Sikhim, Chumbi & Bhutan.** xvii and 267 pp.; map, ills., index. Houghton Mifflin Co., Boston and New York, 1923. 9 x 6 inches.

Lord Ronaldshay, president of the Royal Geographical Society and former governor of Bengal, knows the East not only as an administrator but as a scholarly and sympathetic observer of life and thought. His volume on India, though a "bird's-eye view" which deals mainly with external matters, is much more than a

collection of superficial impressions. His bird's-eye vision penetrates beneath the surface close to the heart of many of India's material and spiritual problems.

Among the numerous topics touched upon are: architecture and architectural sculpture as embodying religion and mythology in stone; the ever-present menace on the northwest frontier; local self-government and village life; the introduction of the factory system into a land where the Industrial Revolution has not taken place. Some see in industrialization the solution of certain of India's difficulties, but Lord Ronaldshay asserts that "the organisation of industries on the lines evolved by the Western nations—industries, that is to say, which . . . necessitate the aggregation of vast numbers of human beings to perform for a fixed wage so much of [an] operation as cannot be performed by [a] machine—is something which is altogether alien to the genius of the Indian people." Lord Ronaldshay feels that India should not be regarded as a nation but as a continent with all the conflicting interests to which the juxtaposition of different nations and regions and traditions give rise. "The existence of the 70,000,000 Moslems in India is the most formidable obstacle in the way of those whose battle-cry is 'India a nation.' "

Perhaps more penetrating and original than any other part of the book are the chapters in which the author undertakes a task few Occidentals are capable of handling, the task of interpreting for Western readers the deeper and more obscure qualities of the Oriental mind. Here he tries to explain the tinge of pessimism, the strain of "submissive sadness" so characteristic of the Hindu. This is partly the result of physical languor induced by almost chronic disease, which is bred in turn by the hot, damp climate and malsanitation. In the villages of Bengal the germs of malaria are in the blood of nearly everyone. The physical cause of pessimism, however, is if anything less potent than the intellectual. From the dawn of history the Hindu has believed that he is bound to the wheel of life, destined irrevocably to suffering and sorrow not only through this wordly existence but through infinite cycles of transmigration. The search for a means of escape from this bondage has been the perpetual quest of the sages of Hindustan.

"Lands of the Thunderbolt" is partly a narrative of travel in Sikhim and Bhutan and partly an explanation of the historical background and essential character of the curiously perverted form of Buddhism that prevails in the eastern Himalayan valleys. Amazing tangles of superstition and demon worship, with a complex mythology and an absurdly mechanical conception of prayer, have grown like weeds about the beautifully logical and cleancut teachings of Gautama. Lord Ronaldshay, nevertheless, sees the influence of that great teacher still alive "among lamas and laymen alike" in "an attractive gentleness and kindliness of disposition, a dignified and courteous hospitality, and withal a cheerfulness and friendliness." The title of the book is taken from the thunderbolt, an emblem of the Buddhist priestly power.

A Geographical Dictionary of Chile

Luis Riso Patrón. **Diccionario Jeográfico de Chile.** xxiv and 958 pp.; bibliogr. Imprenta Universitaria, Santiago, 1924. 10½ x 8 inches.

The author of this volume is well known as a former director of the Oficina de Mensura de Tierras of Chile and chief of the Comisión de Límites, as well as for the great map of Chile on the scale of 1:500,000 compiled under his direction and for various articles on the cartography of Chile. The "Diccionario" is a valuable compendium of the geography of Chile. It comprises over 28,000 short descriptive notes, alphabetically arranged, on the cultural and topographic features of the country. The compilation includes population statistics and descriptive notes on the provinces and centers of population, statistics of mineral and agricultural pro-

duction, location and descriptions of topographical features, altitudes of important mountain peaks, the velocity and volume of rivers, and notes on geography, geology, and rainfall of the various geographical provinces of the country. The material has been assembled in a thoroughly workmanlike manner, and each entry in the dictionary is accompanied by references to the sources of information. The introduction to the dictionary contains an article on the general geography of the republic and a bibliography of nearly 200 entries. Especially valuable is the definition of a large number of geographical terms of purely Chilean usage and also many of Spanish and Indian origin. The volume offers in convenient form a great amount of statistical information which could otherwise be obtained only from unpublished statistics in governmental archives. The work should be of especial value to cartographers inasmuch as it contains much information not set down on any map of the country.

Geographical Data on Minas Geraes

Alvaro Astolpho de Silveira. **Memorias chorographicas.** Vol. 1, 353 and xvi pp.; maps, ills., index; Vol. 2, 355–703 and xxxiii pp.; ills., index. Bello Horizonte, [Brazil,] 1921–1922. 9 x 6 inches.

Scientific knowledge of Brazilian mountains is woefully meager. Massena, Homen de Mello, Glaziou, Liais, Derby, Branner, Hart, and others have labored much to advance the orography of Brazil; but the territory is vast, and much of the earlier work is exceedingly inaccurate. "With the exception of the work of the geographic commissions of Minas Geraes and São Paulo, which made systematic determinations of altitudes in the territory explored by them, we have had little in the way of altimetric exploration. And the number of those who have climbed the important high points in the national territory for the purpose of determining their altitudes will hardly reach a dozen." The condition of affairs that he thus describes Dr. Silveira has sought to remedy. As Chief Engineer of the Commissão Geographica e Geologica de Minas Geraes, he has had abundant opportunity to explore his home state, perhaps the most mountainous in the entire country, and the volumes before us embody many of the facts learned by him during the progress of his explorations.

Volume 1 opens with a discussion of the high points of Brazil. The two highest peaks in the Republic are the Pico da Bandeira and the Agulhas Negras (Pico do Itatiaya), about which more will be said presently. After them are listed fourteen points of more than 2000 meters altitude and nineteen that rise between 1500 and 2000 meters. As might be expected, the former are grouped in the big ranges of Caparaó, Mantiqueira, Espinhaço, and Orgãos. The points of the second category are more widely scattered, though only peaks that rise within the State of Minas Geraes or along its boundaries are considered. This may be explained by the fact that the volumes deal only with this single state; for, as an official of Minas Geraes, Dr. Silveira's explorations were naturally limited to that commonwealth. On the other hand, it may be pointed out that the two highest ranges in the whole of Brazil serve as the southern and eastern boundaries of Minas Geraes while the third in altitude rises in the center of the state.

While these volumes do not pretend to be exhaustive manuals of the regions covered by them, they do contain a vast amount of information of varied character and many new data. The range of subjects discussed includes altitudes, distances, mineralogy, diamond mining, copper mines, wells, climate, husbandry, cattle raising, fruit production, soils, forests, geology, rural medicine and charms, malaria, folklore, religious ceremonies, caves, old Indian inscriptions, and native flora. It may be mentioned that besides his attainments as an engineer and geologist,

Dr. Silveira is a botanist of considerable note in his own land and has himself described new species of plants discovered on his travels.

It is but natural that the two highest mountains of Brazil should excite the greatest popular interest as well as scientific attention. The reviewer was privileged to make an ornithological survey of the more famous of these and a reconnaissance of the higher, and incidentally he climbed both. The former, the Pico do Itatiaya, has for decades been accessible and has attracted workers in the various fields of geography, geology, botany, and zoölogy; and from the beginning speculation has been rife as to its altitude. In 1867 José Franklin da Silva Massena, who had still earlier called attention to the great height and majesty of this mountain, published in his "Quadros da naturesa tropical ou ascensão scientifica ao Itatiaia, ponto culminante do Brazil," the results of a combination barometric and trigonometric computation of the altitude of Itatiaya as 2994.5 meters.

Despite the obviously unsatisfactory methods employed by Massena and the fact that at least four subsequent measurements by as many different engineers have all fallen far short of his calculation (the average is 2821 meters), Massena's figures have been handed down to this day as the true elevation of the peak and appear as such even in the best Brazilian atlas. Thus for more than a century the Pico do Itatiaya has been proclaimed the culminating peak of Brazil. But a few years ago Dr. Silveira measured a peak marking the boundary of the most populous state in the Union and discovered its height to exceed that of Itatiaya by many meters! This is the Pico da Bandeira, the highest point of the Serra do Caparaó (2884 meters).

In Volume 2 are included two chapters on the Botocudo Indians and a third giving a short vocabulary of their language. In this connection it is interesting to note that there yet remains, even within the progressive State of Minas, a large tract of virgin forest, lying between the Rios Doce and Suassuhy Grande and the Serra dos Aymorés, which has yet to be penetrated by civilized man. It is here that the savages find sanctuary. The fact that this region is distant less than three hundred miles from Rio de Janeiro, national capital and a city of nearly a million inhabitants, illustrates what a land of contrasts Brazil really is.

ERNEST G. HOLT

TRAVELS SOUTH OF THE STRAIT OF MAGELLAN

A. M. DE AGOSTINI. **I miei viaggi nella Terra del Fuoco.** 296 pp.; maps, ills. Flli. De Agostini, Turin, [1923.] 125 lire. 11½ x 8½ inches.

ROCKWELL KENT. **Voyaging Southward From the Strait of Magellan.** xv and 184 pp.; maps, ills. G. P. Putnam's Sons, New York and London, 1924. 11 x 9 inches.

South of the Strait of Magellan lies a vast archipelago. Much of it is a wild region of mountains, glaciers, and tangled forests, interlaced by an intricate system of sounds and fiords and swept almost unceasingly by storms from the west. Many of the inlets have never been surveyed, and the mountainous interiors of some of the islands are wholly unknown. A few Alaculoof and Yahgan Indians of a low order of civilization make a scanty living by fishing among the sounds, and here and there a tiny settlement may be seen on the water's edge—a mission, perhaps, or a sawmill, or possibly a lair of fugitives from justice. Immense and almost impenetrable tracts are wholly without population, and west and northwest of Cape Horn the huge swells of the South Pacific beat for hundreds of miles on a treacherous, unlighted, and uninhabited coast. The mountains form the southernmost extension of the Andes and are continued east of Le Maire Strait in the almost fantastically precipitous peaks of Staten Island.

The northern and eastern parts of Tierra del Fuego are very different. Here a wide plain slopes gently to the Atlantic; north of the Rio Grande it is open, swept by furious icy winds in winter, cool in summer, grazed over by two million sheep. South of the Rio Grande the plain forms a park country with woods and meadows. These districts used to be the hunting grounds of the Onas Indians, a people whose magnificent physique, in contrast to that of the puny natives of the coastal zones farther west, gave rise to early travelers' tales of Fuegian giants. But a ruthless war of extermination has been waged against these Indians by land-greedy settlers from the north, and the race is now nearly extinct.

The spell which Tierra del Fuego with its neighboring islands lays upon those who visit it is reflected in the two books under review. Each is the work of a man of imagination and literary power. Father De Agostini was for many years a Salesian missionary at Punta Arenas, at heart an explorer, mountaineer, and man of science as well as a philanthropist. His wanderings in this remote archipelago between 1910 and 1918 took him from the pampas on the north to Cape Horn on the south and from Cockburn Sound in the west to Staten Island in the east. By reason of his wider knowledge of the country and its people, his book is the more informative and geographically the more valuable of the two; Kent's, avowedly the impressions of an artist in search of adventure, the more romantic. De Agostini's volume is lavishly illustrated with photographs, some of which—especially those in color—are of extraordinary beauty. Kent's woodcuts in bold black and white vividly convey a sense of the somber and almost sinister charm of the Fuegian landscape.

Both De Agostini and Kent broke new ground. A dramatic episode in the former's journey of 1913 was the discovery of two deep and hitherto unsuspected fiords penetrating from the head of Keats Sound far into the heart of the western peninsula of Tierra del Fuego and not shown on the charts of the British Admiralty or U. S. Hydrographic Office. One of these fiords was subsequently named after De Agostini by the Chileans. Accompanied by Alpine guides the padre also carried out several risky expeditions among the mountains and glaciers overlooking Admiralty and Beagle Sounds, notable among them being the first ascent of the astonishingly abrupt peak of Monte Olivia, northeast of the forlorn village of Ushuaya. His most important single exploit, however, was the crossing of the main cordillera of Tierra del Fuego from the western end of Lake Fagnano to Beagle Sound at a point a few miles west of Ushuaya. The route lay for several days through almost impassable forest thickets and dangerous bogs, across swollen streams, and over wild mountains. Kent made a similar traverse of the range by a pass somewhat to the west of De Agostini's route.

De Agostini's volume is accompanied by an excellently clear map (1:1,000,000) representing the whole of Tierra del Fuego and the Strait of Magellan. Two small maps (1:400,000) show the vicinity of the De Agostini Fiord and the region between Ushuaya and the head of Admiralty Sound. A full discussion of the glacialogical observations made in the course of De Agostini's expedition of 1913 by G. B. De Gasperi (Primi appunti sui ghiacciai della Terra del Fuoco)—who was subsequently killed in the World War—was postumously published by Giotto Dainelli in a volume of De Gasperi's papers, "Scritti vari de geografia e geologia," Florence, 1922, pp. 221–272.

The Falkland Islands

V. F. Boyson. **The Falkland Islands.** With Notes on the Natural History by Rupert Vallentin. xii and 414 pp.; maps, ills., bibliogr., index. Oxford University Press, American Branch, New York, 1924. $5.00. 9 x 6 inches.

The Falkland Islands have a considerable and interesting history to the narrating of which Miss Boyson devotes half of her book. Part II describes the growth

of the present dominant industries—sheep raising and whaling, with a chapter on the destructive sealing that led to the extinction of the economically valuable species. Part III, entitled "Geophysical Notes" deals with climate, the famous "stone rivers" and the theories regarding them, and the flora. Part IV, "Zoölogy," contributed by Rupert Vallentin, gives the results of his own observations carried on during several visits to the islands. Altogether a useful and informative volume.

Hydrographical Studies on New York Harbor

H. A. Marmer. **Tides and Currents in New York Harbor.** v and 174 pp.; maps, diagrs., index. *U. S. Coast and Geodetic Survey Special Publ. No. 111*, 1925.

Mr. H. A. Marmer gives the results from the detailed observational material for New York Harbor on file in the office of the Coast and Geodetic Survey, the material including a large amount of current data obtained from a recent comprehensive current survey conducted jointly by the U. S. Coast and Geodetic Survey and the U. S. Engineer Office of the First District, New York. The treatment is non-mathematical in character. Of special interest are the first two sections which serve as an introduction to the work. These sections contain an excellent discussion of the general characteristics of the tides and tidal currents, applicable to all parts of the world. This is followed by a discussion of the observational data for New York harbor, special attention being given to the relationship existing between the physical features of the waterways and the tidal movement. For the purposes of the publication the harbor is taken to include not only the Upper and Lower Bays but also East River, Harlem River, Hudson River as far north as Mount St. Vincent, Newark Bay, Kill Van Kull, and Arthur Kill. Each of these sections is treated separately, first for the tides and afterwards for the currents. For each of the waterways charts are given showing the location at which tidal and current observations have been made, and also tables showing the results of these observations. The tidal observations at Fort Hamilton, covering a period of thirty years, afforded a valuable record for the study of changes in the tides and tidal data from year to year. The concluding portion of the work gives a summary of the movement of the tides and currents throughout the harbor. This is illustrated by a set of diagrams, one for each hour of the tidal cycle, on which the direction of the current is shown by arrows and the condition of the tide by the letters "R" or "F," to signify whether the tide is rising or falling.

The work is a valuable addition to our literature on tides and currents, serving not only the purpose of the engineer but also providing the geographer and other scientists with a means for obtaining a better understanding of the tides and currents, especially for New York harbor. Paul Schureman

Physiography of Nova Scotia

J. W. Goldthwait. **Physiography of Nova Scotia.** iv and 179 pp.; maps, diagrs., ills., index. *Geol. Survey of Canada Memoir 140: Geol. Ser. No. 122*, Ottawa, 1924.

It was a happy decision of the Geological Survey of Canada to make available for visitors and local residents a nontechnical yet authoritative account of the origin of Nova Scotian scenery. The task of preparing such an account has been accomplished by Professor Goldthwait in a manner that places both the layman and the scientist deeply in his debt.

Not since Daly's essay on "The Physiography of Acadia" has so useful a study of the physical features of Nova Scotia appeared; and Daly's classic paper dealt briefly with the larger features of a much more extended area. In a volume of a

little less than two hundred pages Goldthwait has given us our first fairly complete account of the physiography of Nova Scotia as a whole. The scheme of treatment is simple, as befits a work destined primarily for general use. A statement of the theory of land form evolution, covering less than three pages, introduces the reader to his subject. The upland peneplain, developed with remarkable perfection in parts of Nova Scotia and giving in northern Cape Breton Island some of the finest examples of nearly flat erosion surfaces on crystalline rocks the reviewer has ever seen described, forms the theme of the second chapter. Under this heading the faulted and warped trap ridge of North Mountain, the history of the drainage systems of the province, and the theories of origin of the upland peneplain are discussed at length. Goldthwait inclines to the opinion that the characteristics of the upland and its drainage favor a subaerial origin for the peneplain, as opposed to the marine origin suggested by Barrell for much of the New England upland.

The author next turns his attention to the lowlands etched out by erosion on broad belts of weak rock and frequently partially submerged by the sea. Then follows a chapter on features due to glaciation in which the author gives the results of his own extensive studies of ice action in the region described. Here the geologist and geographer will find important discussions and conclusions relating to possible centers of ice accumulation and the directions of ice movement in Acadia, descriptions of some of the most remarkable drumlin areas on the Atlantic coast, and very beautiful photographic illustrations of diverse glacial phenomena.

Two chapters on the sea border conclude the volume, one relating to the present forms of the shore, the other to past changes of level. The so-called fiords of Nova Scotia are shown to be submerged normal valleys but little modified by ice action; tidal currents are proved sufficiently strong in constricted passages to excavate or maintain scour holes of considerable depth; and the phenomenal changes in the size and form of Sable Island are illustrated. As for past changes of level, the author describes and explains the significance of elevated beaches and of submerged forests; but his extended analysis of the supposed indications of progressive subsidence in modern or historic time shows that these indications are deceptive, while other evidence is presented to prove complete coastal stability for the last century and a half.

The work is exceptionally well illustrated with effective diagrams, abundant photographs including two beautiful panoramas on folded inserts, and a large physiographic map on the scale of eight miles to the inch.

Douglas Johnson

Animal Life in the Yosemite National Park

Joseph Grinnell and T. I. Storer. **Animal Life in the Yosemite: An Account of the Mammals, Birds, Reptiles, and Amphibians in a Cross-Section of the Sierra Nevada.** xviii and 752 pp.; maps, diagrs., ills., bibliogr., index. (Contrib. Museum of Vertebrate Zoölogy, Univ. of California.) Univ. of California Press, Berkeley, 1924. $7.50. 10½ x 7 inches.

This is primarily an account of a zoölogical survey cross section of the Sierra Nevada, including the Yosemite National Park. It involves an area 89¼ miles in length by 17¾ in width and includes the eastern part of the San Joaquin valley on the west across the Sierras to Mono Lake on the east and thus includes the western part of the Great Basin.

The authors believe that temperature is the major controlling factor in the formation of life zones, but at the same time they point out that on the eastern slope of the Sierras, where aridity is so marked, the zonal arrangement is very confusing. Fires have, no doubt, also been an important factor influencing the boundaries of certain zones, a point to which the authors gave slight attention.

The great bulk of this attractive book consists of an extensive annotated list of the 362 kinds of animals considered. The density of the bird population was determined by careful census studies, totaling 250 of such estimates. The bear population in Yosemite valley is placed at from 15 to 20 and for the whole park at 125. The estimate for the cougars is placed at from 20 to 25 for the park, or about one to a township. The pocket gophers are calculated to excavate during one winter about 3.6 tons of soil per square mile, or for the whole park 4100 tons.

The authors point out the importance of many conservation measures, such as the need of keeping the park in as wild a state as possible; the necessity of dead and down timber for many kinds of animals; the danger to the deer of their being forced to winter on lands heavily grazed by domestic animals; and, it should be added, the menace of diseases derived from domestic animals.

The volume is beautifully illustrated by half-tones, excellent colored plates, and maps. It is the finest volume so far published on the animals of our National Parks.

Charles C. Adams

Scandinavian Faunal Distribution

Sven Ekman. **Djurvärldens utbredningshistoria på skandinaviska halvön.** xvii and 614 pp.; maps, ills., bibliogr., index. Albert Bonniers, Stockholm, 1922. $15.00. 10 x 7 inches.

During the latest glaciation some tens of thousands of years ago all Scandinavia, with the exception of nunataks and islands on the Norwegian west coast, was buried beneath ice. In the ice-free areas an arctic flora and fauna survived the glaciation. The other plants and animals that were not killed by the changed climatic conditions were driven by the expanding ice to central and eastern Europe. Here they mingled with plants and animals that the advance of the glaciers had forced to descend from the Alps and other high mountains. When ice sheet and glaciers waned, mixed nordic and alpine floras and faunas took possession of the uncovered ground. As the age of the retreat in Scandinavia is exactly known, the later geological and geographical events and climatic evolution of Scandinavia are better known than those of any other region. Furthermore, as practically the whole flora and fauna has immigrated since the disappearance of the ice, the Scandinavian Peninsula is fairly unique from the zoögeographical point of view; and Ekman's book, bringing together all the material relating to the fauna, is of exceptional value.

The first part of the book (pp. 1–303) deals with the present distribution of the animals, which are divided into nine geographical groups. The vertebrates are treated separately, while the invertebrates are treated by groups except in the case of forms of unusual interest. This section contains a vast amount of information, in many cases made clear by excellent maps.

The second part (pp. 305–543) discusses the causes of the present distribution and the history of the fauna. It deals chiefly with the relation of the fauna to climate and vegetation, migrations, topographic obstacles to migrations, history of the fauna, sequence of immigration, postglacial history of Scandinavia, time as a zoögeographic factor, relation of the Scandinavian fauna to that in extra-Scandinavian regions, relicts from the interglacial fauna, routes of immigration, effect of the glacial period on the European fauna, endemism, etc.

During the 13,500 years that have elapsed since the ice edge left central Scania and began rapid retreat and the flora and fauna began to immigrate, no endemic species of higher animals have been developed. The Norwegian lemming (*Lemmus lemmus*) to be sure is endemic, but it goes far back in time, having survived the last glaciation on the Norwegian west coast and not in central or eastern Europe.

However, a few new species of crustaceans and insects have originated in postglacial time. Also because of the short time since the land became habitable many forms have not yet reached their natural limits of distribution.

The relict fauna comprises relicts from the arctic sea, that is from the sea bordering the retreating ice sheet, from the transgression of the postglacial sea, from the early postglacial fresh-water stage of the Baltic, from the postglacial stage of the Baltic when the salinity was about twice the present, and from the postglacial temperature maximum which prevailed from about 7000 to 3500 to 2500 years ago. The arctic relicts have undergone important morphological and ecological modifications.

The third part (pp. 545–580) deals with the geographical divisions of Scandinavia, their physical conditions and fauna.

The work is well illustrated, primarily with numerous good maps from which much information can be gained by persons unfamiliar with the Swedish language. The excellent standard of the work as a whole is well shown by the fact that, although written by a zoölogist, the geological and climatological sides are duly considered and their treatment is exact and up to date. It is a work of unusual interest and importance.

Ernst Antevs

Southwestern Greenland: Country and Norse Settlements

N. W. Nissen. **Die südwestgrönländische Landschaft und das Siedlungsgebiet der Normannen.** 112 pp.; maps, diagrs., bibliogr. (Abhandl. aus dem Gebiet der Auslandskunde, Vol. 15.) University of Hamburg, 1924.

This scholarly volume deals with the physical geography of southwestern Greenland, its presumable influence upon the Norse settlements of the Middle Ages, and the probable fate of these settlements. The author has thoroughly combed the available literature on the subject, but unfortunately his monograph appeared too early for account to be taken of the published results of Poul Nörlund's striking discoveries at Herjolfsnes (discussed in this number of the *Geographical Review*, pp. 605–616). It is possible that these discoveries might have led him to modify some of his views.

The work opens with a brief exposition of the little that was known from documentary sources and archeological evidence acquired before Nörlund's excavations in regard to the history, culture, and economic life of these settlements. The settlements, which were primarily devoted to cattle raising, were scattered along the shores of deep fiords that penetrate a strip of land varying from thirty to sixty miles in width and separating the outermost fringe of reefs and islets from the inland ice. Under the influence of the sea, the isotherms in this narrow belt run in general parallel to the coast, though the climate of the interior is somewhat more extreme than it is nearer the ocean. In particular the seaward margin is chilled in summer by the ice-laden current that swings around Cape Farewell. Glaciers discharge into the heads of many of the fiords. It is on the shores of the relatively few ice-free fiords—those into which reefs prevent the entry of ice from the sea and which do not head in glaciers—that the most favorable spots for settlement were to be found, and it is here that the ruins of the Norse farms cluster in the greatest numbers.

The vegetation of the region resembles in some ways that of the higher mountains of the eastern United States. Birch thickets grow, with trees four to five and sometimes as much as six meters tall, in favored localities on the south-facing slopes where the sun shines more warmly and where there is less exposure to the föhn winds blowing down from the inland ice. Willow scrub seems hardier than birch

and is more widely distributed. Grasses are important on damp ground as far north as latitude 61°. Weeds, such as dandelion, lady's-mantle, angelica, buttercup, and representatives of other hardy species, flourish nearer the bleak coast and also farther north and at higher altitudes than the birches, willows, and grasses. Large tracts of heath are covered with dwarfed scrub, lichens, and mosses. But the most extensive plant formation of Greenland is that of the fjeld, which in the region of the Norse settlements occurs at altitudes of 900 to 1000 meters. It is a true desert formation: "the plants here do not make a continuous carpet but unite in little clumps or clusters (*Tue*) between which the ground is often bare over large tracts. Not the vegetation but the soil gives the landscape its characteristic appearance."

Nissen adopts Passarge's system of classifying and describing "landscapes." The various elements of a "landscape" are first analyzed in detail one by one. Broader "landscape types" are then established in which the various elements are combined. Finally there follows a description of fourteen individual "landscapes" (we should call them natural regions), the bounds of which are shown on an outline map. The correlation of the "landscape types" and "landscapes" with the settlements in each is then carefully worked out.

Nissen attributes the disappearance of the Norsemen from Greenland to intermingling with the Eskimos. He discounts the theories that they may have died out or returned to Scandinavia or have been exterminated in wars with the Eskimos. He is strongly convinced that the climate of Greenland has remained unchanged and sees no reason why a population established there in the Middle Ages should not have been able to maintain a living by the methods the Norsemen are known to have practiced. The evidence gathered by Nörlund, however, seems to offer positive proof that, in the eastern settlement at least, a change for the worse in the climate actually took place and with it a positive physical degeneration of the people as a result of increasingly hard conditions of life.

History of the Race Problem

Théophile Simar. **Étude critique sur la formation de la doctrine des races au XVIII^e siècle et son expansion au XIX^e siècle.** 403 pp.; bibliogr., index. *Mémoires Acad. Royale de Belgique, Classe des Lettres et des Sci. Morales et Polit.* Ser. 2, Vol. 16, Fasc. 4, Brussels, 1922.

The author of this paper seems to be engaged with the history of colonial policy in the eighteenth and nineteenth centuries and offers the present memoir as an advance chapter on the history and status of the racial problem in England, France, Germany, Italy, Belgium, and the United States; but, as one turns through the several hundred pages, one discovers that the author has given little more than an outline, that his materials are cited without comprehensive treatment, and that the work as a whole is not well organized. At the outset the author announces his objective as historical; not an inquiry into the phenomena of race, so much as a statement of origins for current beliefs; yet the reader will not go far before coming to suspect that in his own mind the author has solved the problem to his own satisfaction and is engaged in setting the stage for the presentation of his own solution. In other words, he has a racial belief that is fully satisfactory to himself. One suspects this because of bitterness displayed in the citation of contemporary writers on the subject. Again, over and over the author asserts that the doctrines of anthropologists have no part in the formation of these beliefs nor do they enter into the works cited. So the reader is left to surmise that the author's own view of the case is the only one ringing true to anthropology.

Turning now to the positive side of the work under review, we find an opening section on the psychological origins of the race concept which, as an introduction,

is well enough; but the treatment is inconsequential, the main point made being that ethnic groups are conceived as individual entities, which must follow their individual historical evolutions, conditioned in part by the environment and also by their biological characters perpetuated by heredity. The history of the ethnic group concept is an important subject, but the author has not as yet contributed much to our knowledge of it. He conspicuously fails to grasp the nature of the psychological, the biological, and the sociological approach to an understanding of the ethnic group.

This preliminary discussion is followed by the main thesis, which opens with the era of geographical discovery, symbolized by Columbus, and which is taken as the formative period for modern concepts of race, the idea of the author being that contact with subjected primitives stimulated thought on the subject. In this connection also generalities of French social philosophy of the colonial period are enumerated, and some consideration is given to religious thought and missionary activity. Then follows a discussion of anthropology, its development in England and France, followed by a note on the contrast between the spirit of the French Revolution and Imperial England. German thought and philosophy come next into review. The later sections of the work deal with the status of modern thought on the race question, but here as elsewhere the author selects a few names of contemporary writers, briefly but inadequately characterizing their work. For example, his review of American thought is confined to a few bitter denunciations of two or three individuals. Such treatment could give nothing of value to a foreign reader, but it is symptomatic of the whole work.

Clark Wissler

Classification and Distribution of Mankind

A. C. Haddon. **The Races of Man and Their Distribution.** viii and 201 pp.; diagr., ills., bibliogr., index. The Macmillan Co., New York, 1925. $2.50. 8 x 5½ inches.

Those familiar with Professor A. C. Haddon's useful little book "The Races of Man" (1909) will be delighted to know that he has brought out under the same title a much enlarged and totally new volume. As the title indicates, a basis and scheme of classification for the living peoples of the earth is presented, and the geographical distribution of the racial groups is described. As in his earlier work, Professor Haddon takes for his primary distinction the form of the hair, dividing all the living peoples of the earth into three great divisions according as they are characterized by straight hair (Leiotrichy), wavy hair (Cymotrichy), or woolly hair (Ulotrichy). Further, a grouping by these characters results in the large divisions known as mongoloid, caucasoid, and negroid—the traditional divisions. Haddon, however, groups the various populations of the world according to combinations of the following: hair form, hair color, eye color, skin color, stature, head form, face form, nose form. By the use of these criteria in combination he develops sub-groupings under the three main heads just noted. The job seems to have been done well and therefore calls for no further comment. Every classification yet proposed, except those of the most general sort, has been far from satisfactory, because in the end a large number of living tribes must be placed arbitrarily and because no one has as yet been able to make a clear case of the ancestral relations involved.

Professor Haddon is fully aware of these weaknesses in his own scheme and frankly admits the present impossibility of consistently placing all the known living groups. The outstanding merit of the volume under review, however, is that he has faced his problem in something more than a descriptive fashion, since

in the last chapters we meet with certain suggestions and interpretations directed to the very heart of it. His first proposal is that climate is responsible for the whole thing, that in some way the climatic complex registers on the germ plasm and in isolated areas results in differentiations of feature, color, and form. His basic idea seems to be that climate causes differentiation rather than that any particular variety of climate is correlated with one specific character. This implies that the continued occupation of an area of uniform climatic conditions would be adverse rather than favorable to an evolution of racial types; and, though the author does not so state, he leaves one to infer that the climatic shifts in paleolithic Europe are to be considered as a possible factor in the history of man in that area. But perhaps the most suggestive of the author's proposals are those in which he falls back upon the biological background of man to show good and sufficient reasons why the occasional repetition of a character may be anticipated and also whereby the presence of the intermediate and unclassifiable characters may be accounted for as primitive survivals of reversions and not necessarily as the result of the mixture of breeds. In other words, the picture we get of man evolving tends to conform to biological patterns and not to the mechanical artificial alignments of the old anthropology.

Thus Professor Haddon has not only given us a book that every student of man will put on his reference shelf but, in addition, has formulated a number of fundamental problems that must be considered in contemporary anthropological research.

Clark Wissler

A Reported Map of Columbus

Charles de La Roncière. **La Carte de Christophe Colomb.** Map with text in French and English. 42 pp. of each. Éditions Historiques and Édouard Champion, Paris, 1924. 14 x 14 inches.

A little over a year ago there was reported the discovery in Paris of the identical map used by Columbus on his first voyage. This map in colors and also in black and white accompanied by descriptive text in French and English is now before the public.

The discoverer, M. Charles de La Roncière, bases his identification entirely on internal evidence. The map is unsigned and undated. The date is fixed between 1486 and 1492 because the map indicates the southern cape of Africa, discovered in 1486, and fails to show any indication of "America." The maker of the map is successively identified as a student of Ptolemy, a Genoese, and as Columbus, although it is admitted that the writing is not that of the Admiral. His supposed connection with the map is based on inscriptions; one near "Frixlandia," another seemingly taken from the "Imago Mundi," one on the sailing distance to India, one on the Sirens in the Gulf of Guinea, and on the words "Manageta" for Malaguette, and "Agisymba" in South Africa. Because of the supposed date the map is thought to embody the geographical ideas of Columbus at the time of his first voyage. As a final matter of interest it is claimed to reveal, in the island of Antillia, the secret objects of Columbus' first voyage according to the Vignaud theory.

The writer regrets that he cannot agree with M. de La Roncière in his identification. To date the map is not such a simple matter as M. de La Roncière seems to think. It is naïve, at least, to fix the later date limit before 1492 because the map shows no trace of America. This implied that Columbus, who died in the belief that he had reached Asia, would have indicated on his own map another mainland between Europe and Asia. When one considers maps like the Gregorius Reisch, Margarita Philosophica, Friburgi 1503, world maps which failed to show not only the Spanish discoveries but also South Africa and left the Indian Ocean

a closed sea as it had been represented in the earliest Ptolemy maps, one sees that it is not safe to argue too closely as to dates from what is not indicated on a given sixteenth-century map. If a safer course is adopted and one argues from what is on the chart, the date would be put after the Vasco da Gama voyage at least. The map does not have the marked projection of South Africa into the Indian Ocean common to the chart of Henricus Martellus Germanicus and the globes of Behaim and Laon.

It may be granted for argument that the maker of the La Roncière chart was a student of Ptolemy and a Genoese without admitting that he was Columbus. The inscription from the "Imago Mundi" has no necessary connection with Columbus. The mermaid islands appear on the Cosa chart of 1500 and on both the Waldseemüller maps (1507 and 1516) but without the corresponding inscription of the La Roncière map. Columbus had no connection with these maps. The name "Agisymba" appears in a similar place on the Behaim globe and the Bernardus Sylvanus map 1511. As for the argument based on "Manageta" in place of Malaguette, no cartographer who has given painful effort to identifying badly spelled names on sixteenth-century charts would give it much weight. Moreover Managuette is an alternative French form for Malaguette; so the word might point to French influence.

There remains the inscription regarding the distance to India as the sole matter identifying this map with Columbus. Nothing is said in the text about the possibility that Columbus and the chart maker, supposing them to have been different persons, drew from a common source. It would be necessary to prove that nobody but Columbus ever used this particular form of the legend concerning the distance to India, in order to derive value from the argument. Since this is obviously impossible, M. de La Roncière has not done it, and therefore his argument is inconclusive.

If the La Roncière map be examined from the standpoint of Columbian geography as evidenced by his voyages it will be demonstrated that there is no connection between this map and Columbus. Columbus believed that the Ptolemaic estimate of the length of a degree as 66⅔ miles was overvalued. As the writer has tried to show elsewhere (G. E. Nunn: Geographical Conceptions of Columbus, *Amer. Geogr. Soc. Research Ser. No. 14*, 1924) Columbus satisfied himself that a degree equaled 56⅔ miles. Maintaining the 16,000 miles of equatorial distance for the extent of the known world derived from Ptolemy's estimate of 180° in longitude augmented by the 60° called for by the travels of Marco Polo, as shown on the Behaim globe, and dividing by 56⅔ resulted in placing the easternmost point of Asia about 285 degrees east of the Insulae Fortunatae (Canary Islands). Cipangu in turn would be some 30 degrees nearer Europe or about 45 degrees west of the Insulae Fortunatae. Reckoning a degree on the tropic, in round numbers, at 50 miles instead of 56⅔ on the equator, these 45 degrees would represent 2250 Italian nautical miles, or 562½ leagues. Therefore Columbus told his crews, on the first voyage, land would be reached in 750 leagues, allowing sufficient margin apparently to be safe.

Here it is necessary to revert to Vignaud's ideas. Vignaud is led into needless confusion by confounding the geography of Behaim, Columbus, and Marinus of Tyre. Vignaud regards the geographical ideas of all three as identical. They were not. The extent of the known world area represented by Ptolemy and Marinus of Tyre was identical but accounted by the last as 225 degrees in longitude, by Ptolemy as only 180 degrees. Then Behaim was not a follower of Marinus of Tyre, because he represented the mainland of Asia as covering 240 degrees comparing with 225 degrees for Marinus of Tyre. Behaim represented the area depicted by Ptolemy as Ptolemy did—180 degrees in extent. He obtained his 240 by representing what was supposed to be new land. Columbus was not a follower of Behaim.

Behaim and Columbus held different degree values and so represented the same countries under different degrees of longitude. Behaim placed his extreme east of Asia on the 240th degree of longitude which Columbus placed under 285 degrees of longitude.

With these facts and Vignaud's error in mind we are ready to examine the La Roncière map, and at once two things stand out. The Asiatic geography does not at all correspond to the demands of the case. The representation of the south coast of Asia is Ptolemaic, and there is nothing to indicate the great extension of Asia eastwards that is required. The Asiatic coast is made to run northwards with only a very slight additional longitude east of the Ptolemaic lands. There is no Cipangu represented, and Paradise is placed in a different region from where Columbus placed it. According to the La Roncière map Columbus would have had to sail almost half-way around the earth to reach Asia. The alternative, another objective, is ridiculous. The Island of the Seven Cities located in a region he never approached and in a direction he never sailed on any of his four voyages is made the secret objective of the Admiral. Columbus sailed west from the Canaries on his first voyage. He showed some signs of hesitation when about 400 leagues west of the Canaries and looked for land, but when it could not be found he went confidently westwards again. The next uncertainty arose when 800 leagues had been passed without reaching Cipangu, supposed to lie across his path. When 1100 leagues had been passed and he found Cuba it corresponded in position fairly accurately with the mainland of Asia. Then Santo Domingo was identified by the Admiral as Cipangu, but its main axis lay east and west instead of north and south. That is why the Admiral missed finding it on his outward voyage. All of Columbus' voyages are understandable in the light of his actions and the accounts we have of them on the basis of the above geographical concept. The Island of the Seven Cities located far to the north of the Azores while Columbus sailed several hundred miles south of them definitely proves that this particular island could not have been the object of his search. It also hardly need be argued that the map cannot be the Admiral's map in the light of what has been said. It remains for the world no more than it was before M. de La Roncière gave it an undeserved notice, a portolan chart of the sixteenth century.

George E. Nunn

Internal Tides of Seas and Atmosphere and Their Effects

O. Pettersson. **Innere Bewegungen in den Zwischenschichten des Meeres und der Atmosphäre.** 43 pp.; maps, diagrs., ills. *Nova Acta Reg. Soc. Sci. Upsaliensis*, Ser. 4, Vol. 6, 1923, No. 2. Upsala.

The effect of the moon on the earth is usually thought of simply in terms of ocean tide production as shown by the flood and ebb of the surface waters. Little are the internal tides of the ocean appreciated, and still less are tidal forces considered in the category of the important factors of climatic control. But consider what Dr. Otto Pettersson has found. First of all he shows that in the Skagerrak there are tides and marked changes in level in the surface of the Atlantic water under the brackish Baltic outflow. These tides show in a 1-to-3-meter vertical oscillation of the surface of 30-per-1000 salinity, usually found at a depth of 10 to 20 meters. The surface of the sea has a tide of but a small fraction of a meter. The subsurface tide merely changes the speed of outflow of the surface layer. The depth at which a salinity as great as 30 per 1000 is found varies to a large extent with the position of the moon. These internal tides are most pronounced near the autumnal equinox every third year (1922, 1925, etc.) when new or full moon occurs with perigee while the moon is on the plane of the ecliptic, or at "node-apside" as Dr. Pettersson names

it. Great tidal floods sometimes occur, as that of 1.7 to 2 meters on Dec. 4, 1914, in Christiania Fiord and on the west coast of Sweden, when a seiche, induced by a strong low and augmented by an onshore gale, coincided with a spring tide. It is not difficult to appreciate why there were such great flood tides in the fourteenth and fifteenth centuries when the node-apside coincided with perihelian.

Similarly, though the atmospheric tide is extremely minute, there appear to be large inner waves produced by lunar influences on internal boundaries in the atmosphere. The circular oscillatory wave motion, combined with the deflective effect of the earth's rotation should produce cyclones over the smooth surface of the North Atlantic. Lunar periods are such as to bring major tidal effects at intervals of 3, 8, 9, 10, 18, 36, 54, 84–93, 176–185, and about 1850 years. Since the peak effects of these periods have come in autumn or early winter during the last few centuries, their expressions should be found in the characters of winters. There is, for example, a noteworthy 8-year period of mild and severe winters. The 140-year New Haven temperature record stands out even more clearly than the European ones, there being an almost unbroken series of mild winters every 8th year from 1788 to 1922. Others can be recognized as climatic as well as hydrographic periods. This is especially true of the 9-year and 10-year periods in the winter temperatures of Stockholm and Berlin since about 1760. But the repetitions come and go, for the coincidence of certain lunar periods with one another is not exact. Thus, after decades of being practically in step they fall out of step, only many years later to get back into step again. In the meantime, however, other combinations have taken up the 8-, 9-, or 10-year rhythms. So at practically all times there are two or more of each of these traceable. The period of instrumental observation is not long enough to establish the presence of the longer periods, though that of 180 years is strongly suggested, with the minimum about 1822 and with the 70 years before and after averaging the same. A record of ice break-up in Lake Mälaren, from 1712 on, corresponds to conclusions reached from the somewhat shorter instrumental records. The temperatures of London since 1764 have also corresponded to those of Berlin and Stockholm in showing the lunar periods in the same phase. So do the ice record of the Neva River and the sea temperature of western Norway. Vienna, however, is not in parallel.

The 1850- or 1900-year period of the coincidence between node-apside and perihelian has been fully discussed in an earlier monograph (reviewed by Ellsworth Huntington in *Geogr. Rev.*, Vol. 1, 1916, pp. 196–201). In this more recent paper Dr. Pettersson summarizes his arguments, adds some further details, and answers criticisms.

Charles F. Brooks

Earthquakes and Earthquake Lore

F. de Montessus de Ballore. **La géologie sismologique: Les tremblements de terre.** xiv and 488 pp.; maps, diagrs., ills., indexes. Librairie Armand Colin, Paris, 1924. 50 fr. 10 x 6½ inches.

F. de Montessus de Ballore. **Ethnographie sismique et volcanique ou les tremblements de terre et les volcans dans la religion, la morale, la mythologie et le folklore de tous les peuples.** vii and 206 pp.; indexes. Edouard Champion, Paris, 1923. 10 x 6½ inches.

The three volumes, "Les tremblements de terre: Géographie séismologique" (1906), "La science séismologique" (1907), and "La géologie sismologique," make up the most complete treatise on earthquakes that has so far appeared, and they form a fitting monument to the work of the distinguished author (see obituary notice in the *Geogr. Rev.*, Vol. 13, 1923, p. 633).

The present volume may be divided into three parts: a short introduction classifying earthquakes; the main part, giving descriptions of many earthquakes, es-

pecially the earth movements affecting the topography; and a final chapter on the distribution of earthquakes.

The author classes earthquakes as (1) glyptogenic, or geologic, and (2) external dynamic. He points out that the second group, which comprises volcanic and downfall shocks, is quite unimportant. All the great shocks belong to the first group, which he again divides into tectonic and epirogenic, according as they are due to movements, largely horizontal, connected with the folding of the rocks, or to the general elevation or depression of large continental areas; and he adds a third group consisting of a combination of these two. In his "Géographie" he found that 95 per cent of the earthquakes of his immense catalogue occurred in two zones which coincided with the Mesozoic synclines, regions which have been folded and in places raised into the greatest of our mountain chains; and he was led to the empiric law that the folded structure of the geosynclinals is unstable and that the tabular structure of continental plateaus is stable. He knew that this law was not universal; and further consideration of earthquakes like the New Madrid, the Charleston, those of northern China, and others outside of these geosynclines led to the introduction of his epirogenic class. The value of this classification may be questioned, especially as the author finds it often difficult to decide into which class a particular earthquake should be put. He regards earthquakes as due to the weakened survival of forces which caused the relief of the earth's surface; but may not these forces in some regions be as strong as they ever were?

The California earthquake of 1906 made it clear that earthquakes are due to earth movements; recognizing this, Count de Montessus has collected, in the main part of his books, accounts of earthquakes that have been accompanied by serious changes in the topography, and he attempts to distinguish between the real earth movements and the slumping of loose material. These descriptions with maps and illustrations will be of great value, for the original accounts are in many cases difficult of access.

A few chapters are devoted to secondary effects, such as landslides, mud flows, the influence of the geologic foundation on intensity, etc.; and then follows the last chapter of eighteen pages on the distribution of earthquakes—a chapter of special interest, for in this branch of seismology De Montessus had led the world. In his "Géographie" he had studied the distribution of earthquakes occurring on land or very close to it. He now examines the distribution of 881 strong earthquakes recorded by Milne seismographs in 1899–1909, whose origins had been determined from the seismographic records. He finds that 74 per cent occurred under the water, and this is closely the ratio of the water area to the whole area of the earth; therefore he concludes that earthquakes are not influenced by land or water. The conclusion is probably correct, but its basis is not satisfactory, for earthquakes are not scattered promiscuously but are to a large extent localized in special regions. Milne's earlier catalogue of destructive earthquakes, all occurring on or close to the land, recorded an average of 31 annually; and Milne estimated that about 30,000 perceptible earthquakes occurred every year, or 1000 for every violent shock. Applying the same ratio to the 881 violent shocks recorded for the whole earth, land and water, in eleven years, De Montessus concludes that about 80,000 shocks strong enough to be felt near their origins occur every year. The 881 shocks are largely concentrated in groups—near the end of Kamchatka, east of Japan, from the coast of China southward through the Philippines to New Guinea, northeast of New Guinea (though the island itself seems to be almost exempt), and again farther east. These are the regions of the earth that are most unstable seismically. The mesozoic geosyncline is supposed to trend south through New Zealand; but only a few shocks were recorded in that region, whereas south of Australia is a region of strong shocks. So De Montessus thinks that his former law will have to be modified.

In his patient collection of earthquake data Count de Montessus de Ballore accumulated a vast mass of information on the popular ideas of seismic and volcanic phenomena—fables, myths, and folklore tales. These he brought together in his "Ethnographie sismique et volcanique . . . " They come from many parts of the world and show how strongly these scourges have impressed the human mind. They have one characteristic in common, namely, they show the tendency to ascribe to the supernatural anything that is not understood; a tendency which has not yet, by any means, disappeared. Many legends ascribe earthquakes and volcanic outbursts merely to the bad tempers of the gods or the demons, or to quarrels between them; many assume that the phenomena are sent as punishments; some look upon them as portents.

It is with deep regret that we close these volumes and realize that we shall have nothing more from the pen of the author, who has added so much to our knowledge of earthquakes.

Harry Fielding Reid

Graphic Illustration in Earth Science

A. K. Lobeck. **Block Diagrams and Other Graphic Methods Used in Geology and Geography.** xi and 206 pp.; maps, diagrs., ills., bibliogr., index. John Wiley and Sons, Inc., New York; Chapman & Hall, Ltd., London, 1924. $4.50. 8½ x 11 inches.

To say that Professor Lobeck's book on "Block Diagrams" is the best work of its kind would be inadequate. It is the *only* work of its kind and a most excellent work at that. For curious though it may seem, the greatly extended use of block diagrams has up to the present inspired no book on the methods of drawing them. Professor Davis, who gave currency to this most valuable form of illustration by employing it extensively in his writings with a skill not previously attained, gives only occasional suggestions on construction, as those incorporated in his "Erklärende Beschreibung der Landformen." Lobeck's work, therefore, supplies a long-felt want and supplies it in such manner as to place all geologists and geographers greatly in his debt.

After a brief introductory account dealing with the general nature and uses of block diagrams, the author devotes two chapters to the methods of drawing rectangular blocks in one-point and two-point perspective. Directions for correctly transferring geological cross sections to the exposed sides of the blocks, for exposing cross sections within the blocks, for transferring data from topographic quadrangles directly to blocks, and other useful information are given; while the results of erroneous methods are ingeniously shown in blocks incorrectly drawn.

Once the student has mastered the art of drawing simple blocks of different types, he is ready to carve in those blocks the varied forms of the earth's surface. To aid him specific directions are given in a series of chapters describing methods of representing plains and plateaus in different stages of dissection; dome, folded, block, and complex mountains; volcanoes; and the forms especially characteristic of stream, glacial, and wave erosion. Simpler forms are discussed first, and progress toward more complicated features is gradual, with successive drawings to aid the student at each step in his advance. The sense of realism is heightened by making many of the blocks represent actual parts of the earth's surface, most frequently the areas of specific quadrangles of the United States topographic map. But foreign maps are also employed as the basis for expressive diagrams, while references are given to additional maps from which the student may construct original diagrams similar to those in the text.

So much for the major portion of the work. The usefulness of the book is broadened by the addition of a discussion on "isometric diagrams and problems in struc-

tural geology"; a section devoted to special methods to be used in constructing more elaborate block and other physiographic diagrams, illustrated by particularly excellent specimens of the author's art; and finally one section each on landscape sketching and on crystal drawing.

In a work so excellent it is perhaps ungracious to dwell on minor imperfections. Yet the critical reader might suggest a few improvements for a new edition, to the end that all parts of the volume may be raised to the same high level. The chapter on volcanoes is disappointing. Here we find nothing of the author's own creation, but only copies of work by others, for the most part wholly unlike anything in the preceding part of the text. The contrast is abrupt and disconcerting, for even the diagrams by Davis are of a different style from those by the author, while the bird's-eye view of Cinder Cone and the maps of the Azores do not seem to fit well into the scheme of treatment at this point. Slips of lesser importance are found in Figure 58, where plateaus in late youth or submaturity (*B* and *E*) are called "mature" and where impossible conditions as to successive depths of stream cutting are represented (*D*, *E*, *F*); in Figure 63, where again a submature plateau is called mature, although the text makes clear the impropriety of the term; in Figure 68, where what appears to be an overlapping portion of the coastal plain is apparently incorrectly labeled "Oldland"; on page 97, where the definition of a mature stream needs revision, and the statement that "none of our large rivers have passed beyond the mature stage" seems to need rephrasing to make clear the fact that streams which are at least late-mature are fairly common; on page 110 and in Figures 160–162, where the youth and maturity of cirques are confused with the youth and maturity of the mountain mass in which the cirques are cut, and where the term *arête* is incorrectly spelled in a number of places.

These are, however, mere matters of detail. The only question of principle likely to provoke difference of opinion is the extent to which devices of mechanical drawing are introduced as an aid to depicting the highly variable forms of nature. Some may feel, for example, that since river curves seldom, if ever, approach segments of circles of uniform diameter, the scheme of drawing river curves outlined on pages 29–31 is of doubtful value and might well give place to greater emphasis on the suggestions for free-hand sketching of river curves. Certainly the use of the ellipse as an aid to drawing alluvial cones does not give happy results (Figs. 112, 113). The cones give an impression of rigidity, of failure to extend laterally the normal distance, and of lacking the slightly concave (upward) profile characteristic of these forms; while the wave-formed terrace (Fig. 112 C) based on subsidiary ellipses seems unnatural because it shows wave cutting only and does not represent the equally important wave-built part of the terrace, formed of the eroded débris. Perhaps it sufficiently answers this criticism to say that any student who masters the more rigid geometrical forms will be able to produce passable diagrams even if he is endowed with no artistic ability; while the man of artistic talent will quickly advance to such free-hand modifications of the cruder forms as will make of them realistic representations of nature. In any case it would help if the author would add one further stage to more of the avowedly "rough sketches" in order to show, as he has beautifully done in Figure 139 and elsewhere, a freer handling of the subject.

Douglas Johnson

The Geography of Art

Kurt Gerstenberg. **Ideen zu einer Kunstgeographie Europas.** (Bibliothek der Kunstgeschichte, edited by Hans Tietze, Vol. 48–49.) 28 pp.; ills. E. A. Seemann, Leipzig, 1922. M. 2 gold. 7 x 5 inches.

A professor of the history of art at the University of Halle advocates a new method of studying art, a method which he calls "Kunstgeographie," or the geography of

art. From the geographer's point of view "Kunstgeographie" is one aspect of human geography. Now, human geography is certainly not an exact science; perhaps in its present stage of development it is not even a science at all. It has, however, developed beyond the point where broad generalizations should be made in it without circumspection. This is where the outsider (not to speak of the geographer himself) who ventures into this field should be on his guard. The historian of art should ponder long before correlating the facts of art, about which presumably he knows something, with geographical facts and processes and probabilities with which he cannot be any too familiar.

In some places it is hard not to feel that Gerstenberg draws a pretty long bow in his generalizations, and elsewhere we are conscious of that disturbing sense of inconsistency all too common in books on anthropogeography. If we agree with Gerstenberg that the seas tend to exert a unifying influence upon the art around their shores, we cannot help wondering whether great rivers really *do* tend to form boundaries between different regions of artistic style owing to the swamps and forests along their courses. Natural influences, argues Gerstenberg on page 4, are more potent than political forces in determining the regional relations between artistic styles and groups of styles. On page 10 he asserts that the Alps have never been an "art-geographical" boundary between Italy and Germany; that the Apennines mark the true frontier between the region of pure Italian art and that which has undergone Teutonic influence. Doubtless these facts are true enough, but they do not seem to jibe with the argument on page 4. The Apennines are certainly not as mighty a natural frontier as the Alps. We have a suspicion that the reason why Germanic influence is marked in the Po valley has something to do with the cultural relations that existed in the Middle Ages between that region and southern Germany and that the latter had a great deal to do with the Holy Roman Empire, a political organization which straddled the Alps. Might it not be argued that political influence upon art was here stronger than that of natural environment?

However this may be, Gerstenberg's central idea is an original and useful one, capable of further development, and his statements of fact regarding the distribution of art and the nature of its dissemination are probably reasonably accurate. He is quite right in asserting that maps showing the distribution of styles of art should not be omitted—as they nearly always are—from large atlases, any more than maps showing the distribution of languages and religions, manifestations of the human spirit no more important than art. Perhaps the practical difficulties of discriminating between styles are greater than Gerstenberg would have us believe, and regions characterized by a broad uniformity in the forms of all the arts ("Kunstgemeinschaften") are somewhat more illusory than he thinks. There will always be more room for disagreement here than in the case of religious and linguistic regions. It should not, however, be impossible to mark off such regions, and we are quite ready to believe that Gerstenberg's attempt to do so falls somewhere near the truth.

He traces five zones each characterized by a distinctive "Kunstgemeinschaft" running in a southwest and northeast direction across Europe. The first zone includes Normandy, Britain, Iceland, and Norway; the second, in which Hanseatic influences were felt, takes in Flanders, Holland, Denmark, the north German coast, and Baltic provinces; the third lies at the interior of the coastal zone, running eastward from central Germany into Poland and westward into France; it is sharply marked off on the south from the fourth zone which betokens the proximity of the mountains and includes Switzerland, South Germany, German Austria, and Bohemia. The fifth zone, that of northern Italy, would seem to have many affinities with the second, or northern coastal zone. We are left in doubt regarding Spain, central and southern Italy, and the Balkan Peninsula.

CORRESPONDENCE

Another letter received from Colonel Fawcett is dated Bakairi Post, Matto Grosso, May 20 (see the July number of the *Review*, p. 520). The position of the post is latitude 14° 15′ S., longitude 54° 32′ W.; the altitude is 1480 feet. Extracts follow:

With vicissitudes of various kinds incidental to these localities of shocking trails and extremely sparse population the expedition has reached this point at the end of civilization in Matto Grosso and in touch with the Indians. The three of us are well and fit. In two days we leave here with two peons for the north. Five days later we shall have reached the point beyond which the peons will not go, for they have an abiding terror of the aborigines. From there the three of us will pursue the journey with six of the best animals, hoping that it will be possible to make use of them for at least a month. Not even the Indians of the Xingú who come here in small parties now and again know what exists away from the rivers. The Indians of the western side and the Tapajóz seem to be better informed, owing possibly to their contact with the Caxabis, a large and aggressive nation of bright copper people who inhabit the vicinity of the Paranatinga and Arinos Rivers. It is the bright copper people who seem to be so much more advanced in art and so suggestive of a superior origin. A party of Mináco Indians from the Xingú is here at present, but I can extract little out of them. They are a brown people, that is nearer the original Tupi, carrying as is usual with the brown types a strong suggestion of the Turanian race. The Xingú Indians are easily recognizable, for all cut the hair in a sort of mop form with a two inch tonsure, the origin of which is obscure.

The Bakairis have been dying out ever since they became civilized. There are only about 150 of them. Small parties of Xingú Indians from the Nahagua and Mináco come occasionally for what they can get and are a much finer people. Rubber gatherers and Caxabi still kill one another in the Paranatinga. From the east the cowardly Caiapo Indians, a stick-throwing lot, raid the plantations, kill when they can, and inspire much terror. Bakairi Post seems to me to present a first-class field for American or British missionary enterprise—a medical missionary. At this altitude it is potentially healthy, not too hot, and much excellent work could be done. Most probably contact could be gradually made with the remoter tribes.

We expect to be on the edge of the old civilization in a month from now and hope to reach its focus by the end of August. It certainly is a most interesting field of research if only for its geographical character and the intriguing nature of the inhabitants. But the insects are discouraging. Even here the flies are a nuisance, and we are literally covered from head to foot with itchy tick bites, mainly the tiny ones about half the sectional area of a small needle.

INDEX

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ERRATA

p. 142, line 6 from bottom: *for* eleventh *read* twelfth.

p. 430, line 15 from bottom: *for* 1 *read* 2, and *for* 2 *read* 3; and so on throughout the article adding 1 to all figure references in the text.

p. 496, line 21: *for* Spawn *read* Splawn.